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Method for assessing organizational readiness to innovate in clothing and textile industry: Insights towards circular economy

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ABSTRACT

Within the all-encompassing approach towards the circular economy, the clothing and textile industry is also undergoing a significant transformation towards sustainability. Central to this transformation is the adoption of innovative practices. A thorough understanding of the key factors driving innovation adoption is needed. This research aims to identify and analyse the critical factors influencing innovation within the clothing and textile industry, focusing on integrating circular economy principles. The authors aim to design a method for assessing organizational readiness to innovate. The research question is: What are the critical factors driving innovation within the clothing and textile industry, specifically within the circular economy? The research methods include a systematic literature review, an online survey, correlation analysis, an analytic hierarchy process survey, and factor grouping. The findings reveal 21 crucial factors in 7 functional groups influencing various types of innovation: research and development, both in-house research and external research services, as the most important group of factors; knowledge acquisition from external sources such as investors, other companies and industries; conferences/exhibitions; higher education and research institutions; managerial intentions and communication; strategy and innovation culture; employee education, training and attitudes; and company parameters such as location and workers' salaries. Each factor has a particular calculated importance level of weight; therefore, business managers can focus on solving the most relevant factors in conditions of limited resources. The research's originality and valuable practical implications are the designed organization's readiness assessment method, which has real-world application as a complementary, practical management tool in the circular economy context.

1. Introduction

With the shift in purchasing power, today's consumers increasingly want to buy products made from environmentally friendly materials whose manufacturing process has the least possible environmental impact (Malhotra et al., 2024; Nielsen, 2015; Reddy et al., 2023). One way to make manufacturing greener is for companies to move towards a circular economy that attracts today's consumers and gives companies other business benefits, new profit opportunities, reduced supply chain volatility, protected stocks, and new services. The economic benefits of a circular economy also include employment and economic growth, job creation potential, and positive environmental benefits – less greenhouse gas emissions, healthier and more resilient soils, and less waste and pollution.

The clothing and textile industry (CTI) has continuously grown (Ong et al., 2021). It is resource-intensive, as the total greenhouse gas emissions from textile manufacturing are 1.2 billion tons of CO₂ per year, greater than the total emissions from all international flights and maritime transport, and consumes 93 billion cubic meters of water (The World Bank, 2019). The textile industry has also been identified as a major driver of plastics entering the ocean (Interreg Europe, 2020). New consumption trends, new technologies, and usage patterns are driving the move towards a circular economy, and this drive is based on innovation (OECD/Eurostat, 2018).

It is necessary to produce more durable products from environmentally friendly materials (product innovations), make manufacturing as environmentally friendly as possible (process innovations), and produce only what is needed (organizational innovations). Several models and

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frameworks have been designed to introduce and manage innovation (Dubickis, 2021; Ideanote, n.d.; KTH Innovation, n.d.; Teece et al., 1997; Tornatzky and Fleischer, 1990), yet they exhibit recurring limitations such as a) lack of sector-specific operationalization for clothing and textiles and for circular-economy objectives (e.g., TOE and dynamic capabilities frameworks offer high-level determinants but no CTI-specific measurement scales or cut-offs; b) absence of transparent weighting/prioritization of factors to guide managerial trade-offs (e.g., practice-oriented tools do not disclose construct validity or weights; and c) limited empirical validation linking scores to realized innovations in CTI, particularly under circular-economy dependent variables (e.g., readiness ladders are largely heuristic; d) regional work focuses on technology transfer rather than firm-level readiness to innovate. These gaps motivate our sector-specific, empirically derived model that (a) delimits factors via SLR, (b) measures firm-controllable dimensions aligned with CE-consistent dependent variables per the Oslo Manual, (c) weights factors using AHP expert judgments, and (d) validates the equations against reported innovations. Consequently, for CTI companies to introduce innovations more effectively, it is essential to determine which factors influence innovation and to what extent. Open innovation, a concept introduced by Chesbrough (2003), focuses on leveraging external resources to introduce innovations. It drives sustainable business model innovation dynamics (Yun and Zhao, 2020). This indicates a research gap that the authors are filling by contributing to a more thorough understanding of the key factors driving innovation adoption and their level of practical influence. Therefore, a study is carried out on the relationship between various factors and the introduction of innovations, particularly in the context of the circular economy. The research aims to identify and analyse the critical factors influencing innovation within the clothing and textile industry, focusing on integrating circular economy principles and designing a method for assessing organizational readiness to introduce such innovations.

Building on the abovementioned gaps, our study advances the field by defining an organization readiness construct to introduce innovation tailored to the clothing and textile industry, aligned with circular-economy objectives. The construct spans seven factor groups and 21 measurable factors that differentiate innovation drivers across product, process, and organizational innovation. Methodologically, we triangulate a systematic literature review, firm-level correlation evidence, and expert AHP judgments to derive empirically weighted readiness equations. We validate them by showing that our sample's computed readiness increases with realized innovations. This yields a sector-specific, empirically validated alternative to generic readiness frameworks.

The structure of the paper is built on six consecutively implemented stages, forming a coherent and systematic methodology. Starting with the literature review, each of the following stages is purposefully developed based on the outcomes of the previous stage, ensuring methodological continuity and depth. The systematic literature review of prior research on innovation and the circular economy led to the identification of factors influencing innovation, the formulation of hypotheses, and the definition of dependent variables, the functional dimensions of innovations based on the principles of implementing the circular economy, which were used further to test the hypotheses. The methodology chapter outlines the data sources and empirical research design, including survey and analytic hierarchy process (AHP) questionnaire development, respondent sampling, factor-innovation relationship analysis, expert assessments, and the creation of evaluation equations to assess clothing and textile companies' readiness to innovate within the framework of the circular economy. The results chapter presents the results of the company's survey, correlation analysis for the evaluation of the relationships between the identified innovation influencing factors and different types of innovations, and expert AHP assessment to quantify the evaluations of the factors and their groups, leading to the development of the assessment method and its validation. Furthermore, the discussion interprets the empirical findings in relation to the literature, highlighting both consistency and divergence, such as

the varying influences of company size, R&D, and employee-related factors on different types of innovation, as well as the assessment model's practical relevance, emphasizing its value as a decision-making tool for managers and policymakers. Finally, the conclusions summarize the major findings, present the research limitations and implications, and provide suggestions for further research.

2. Literature review

2.1. Identification of factors

Although fundamentally rooted in scientific sources, the key literature review begins by justifying and exploring conceptual frameworks, highlighting the necessity and demand for innovation. This exploration encompasses various social, economic, and political pressures that drive the adoption of innovative practices in the context of sustainability and a circular economy, particularly within the clothing and textile industry. The conceptual topicality review delves into information sources of policy-guiding and practical-statistical-reporting characteristics (Eionet, 2019; EURATEX, 2024; European Commission, 2019, 2023; European Environment Agency, 2022; European Parliament, 2021; OECD/Eurostat, 2018; The World Bank, 2019; UNEP, 2024), providing a comprehensive understanding of the contextual landscape shaping innovation in the sustainability and circular economy context, particularly within the clothing and textile industry. A systematic literature review (SLR) of scientific sources was conducted to collect and study the factors affecting the introduction of innovations in general and in the clothing and textile industry, as well as to understand the importance of various factors. SLR identifies, selects, and critically evaluates research to answer an explicit question (Pati and Lorusso, 2017). SLR results are obtained from published literature in scientific databases such as ScienceDirect, Scopus, ResearchGate, SpringerLink, and Google Scholar. The authors conducted the SLR in two blocks: the first (SLR-1) focused on general innovation factors across industries, and the second (SLR-2) targeted factors specifically affecting innovation in the clothing and textile industry. The following search filters, key-word strings, inclusion-exclusion criteria, and content-based restrictions were applied (Appendix A and Appendix B): the keyword combinations used included String 1 – “all in title: factors AND innovation AND industry” for SLR-1 and String 2 “all in title: factors AND innovation AND clothing OR textile OR apparel”, and String 3 “all in title: Innovation AND clothing OR textile or apparel AND industry OR firms” for SLR-2. The search subject areas were kept to business, management, innovation, and manufacturing. Broad inclusion criteria included the availability of articles in English and their full online access. Content-wise, SLR-1 included studies on innovation in any industry except clothing and textiles, whereas SLR-2 included studies specifically addressing innovation in the clothing and textile industry. The following content-wise restrictions were used for the inclusion criteria: only process, product, and organizational innovations were studied, and only those factors that are directly or indirectly dependent on companies were studied in further detail. Conversely, articles focused on eco-innovation, green innovation, or innovation policy were excluded from the final selection. The first broad results of SLR-1 identified 144 articles for innovation search in general (all sectors), and SLR-2 resulted in 184 articles for innovation search in the clothing and textile industry. The abstracts and conclusions of the preselected articles were reviewed on the basis of defined inclusion and exclusion criteria. After applying the inclusion and exclusion criteria gradually, 57 articles were selected for complete analysis. A few of the most commonly used articles exploring the most popular impact factors are as follows: employee-related factors (Gomes et al., 2015; Pourmojib and Godfrey, 2019; Yadav and Saini, 2016), knowledge-related factors (Gomes et al., 2015; Pourmojib and Godfrey, 2019; Sivalogathan and Wu, 2015; Wadho and Chaudhry, 2018), customer-related factors (European Commission, 2015; Chen et al., 2017; Sivalogathan, 2016; Yadav and Saini, 2016), and governing

policy factors (Rosendo and Scheffer, 2015; Wadho and Chaudhry, 2018).

In the first SLR search, which focused on factors influencing innovation in general, including sectors other than clothing and textiles, 17 factors were identified among 15 articles, of which the top 3 most often explored factors influencing innovation are Employees (explored in 8 articles), R&D (6 articles), and Management (6 articles). Appendix C presents the results, authors, and factors that are considered in each of the articles, including sectors other than clothing and textiles, that affect innovation in general.

In the second SLR search on the factors affecting innovation, specifically in the clothing and textile industry, 17 factors were identified among 42 articles, of which the top 5 most often explored factors influencing innovation are Employees (examined in 14 articles), Knowledge spillover (11 articles), Customers (10 articles), Government policy (10 articles), and Market (9 articles). Notably, the importance of knowledge spillover is found to be an essential factor for innovation in the clothing and textile industry, but it was mentioned much less in non-industry-specific articles. Appendix D shows the list of authors and the factors considered in the respective authors' research papers that influence innovation, specifically in the clothing and textile industry.

Combining both SLR searches, 23 factors influencing innovation were found (Appendix E for the SLR results concerning the factors influencing innovation).

The identified factors were then grouped across two dimensions: 1) internal (company-dependent)/external (company-independent) factors and 2) factors focused on CTI/other industry/or shared. 13 internal and 10 external factors influencing the innovations were grouped. Exports and quality management were only internal factors in the clothing and textile industry. In contrast, customer orientation, company location, and cooperation were listed only in companies in other industries. External factors, risk, market, economy, and innovation protection were listed only in the clothing and textile industry, whereas turmoil and suppliers were listed only in other industries. Fig. 1 below shows the 23 grouped factors influencing innovation. Given that the impact of external factors on companies is principally the same for all companies and that companies generally cannot affect external factors, these factors are therefore not hypothesized further in the study. However, their content-related aspects are considered and disseminated in the context of internal factors.

Furthermore, the factors are grouped into seven functional groups

Table 1
Functionally grouped hypothesized factors influencing innovation.

Group/Factors/Hypothesis#/Code for eq.	Group/Factors/Hypothesis#/Code for eq.
1st group – Company parameters	4th group – Research and Development
1. Company location H1.1 (CL)	13. Internal research H4.1 (IHR)
2. Company size H1.2	14. External research services H4.2 (ERS)
3. Company age H1.3	5th group – Management
4. Employee salaries (blue collars) H1.4 (SBCW)	15. Commitment to innovation H5.1 (MGKT)
5. Employee salaries (white collars) H1.5	16. Importance of innovation (goal) H5.2 (MGTI)
2nd group - Employees	17. Employee motivation H5.3 (EM)
6. Employee education degree (white collars) H2.1 (ELWCW)	18. Communication with employees H5.4 (IE)
7. Regular training H2.2 (ISTE)	6th group – Export and competition
8. Vacancies filled with qualified (skilled) employees. H2.3	19. Export groups of countries H6.1 (EGC)
9. Attitude towards change processes in company H2.4 (EA)	20. Intensity of competition H6.2 (CI)
3rd group – Organizational Strategy and Culture	7th group – Knowledge spillover
10. Long-term business strategy H3.1 (LTBS)	21. Knowledge gained from customers H7.1
11. Decision-making H3.2 (DBS)	22. Knowledge gained from suppliers H7.2
12. Innovative company culture H3.3 (ICC)	23. Knowledge gained from investors H7.3 (KI)
• Customer orientation H→H7.1	24. ..from other companies in the industry H7.4 (KCI)
• Funding (investment in R&D) H→H4.1/H4.2	25. ..from companies in other industries H7.5 (KCOI)
	26. ..from conferences/exhibitions H7.6 (KCE)
	27. ..from higher education and research institutions H7.7 (KHERI)

Source: Developed by the authors on the basis of the SLR results.

(Table 1), and according to the research design and methodology, based on the systematic literature review results, the authors define the hypotheses for an empirical study to test and select the statistically significant factors influencing innovation.

Beyond frequency counts, the SLR reveals several tensions. First, firm demographics show mixed or no effects across studies – some associate larger size and greater age with stronger innovation capacity (Koberg et al., 2003; Yang et al., 2010), whereas others report negative or null relationships, especially for product innovation in younger vs. older firms (Aful, 2010). Second, knowledge channels are uneven: many CTI works foreground customers and suppliers (European Commission,

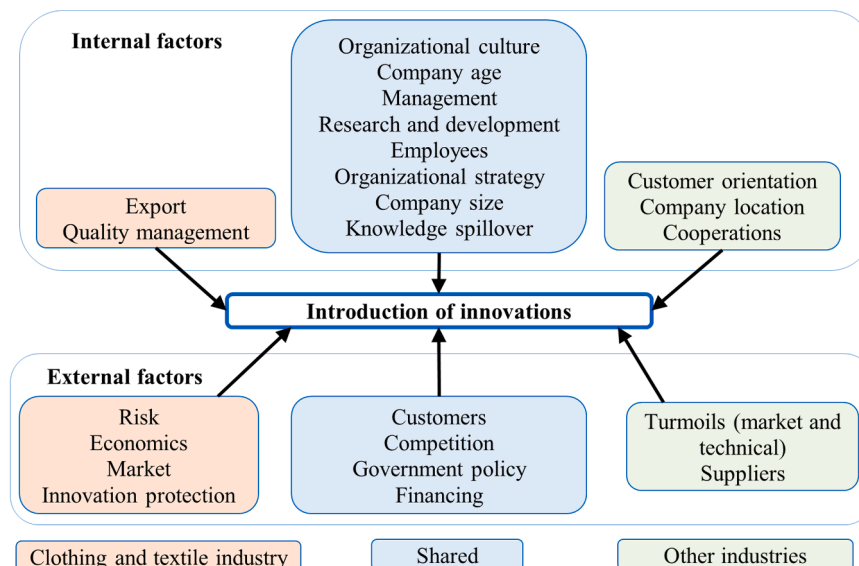


Fig. 1. Grouped factors influencing innovation. Source: Developed by the authors based on the SLR results.

2015; Rosendo and Scheffer, 2015; Gomes et al., 2015; Chen et al., 2017), while others emphasize cross-industry exchange, higher-education/research linkages, and investors (Ju and Lee, 2020; Dubickis and Gaile-Sarkane, 2021). Third, market exposure shows context dependence: competition can spur innovation but varies by source and setting (Montalvo et al., 2011), and exporting to post-industrial markets is often linked to stronger capabilities (Eusebio and Andreu, 2005; Wadho and Chaudhry, 2018). Fourth, funding effects are inconsistent across instruments and firm types (Odei and Novak, 2020; Huergo and Moreno, 2014). Across these streams, most frameworks are not CTI-specific, seldom align explicitly to circular-economy outcomes, examine a comparatively small subset of factors, and rarely report empirically derived weights or validation against realized innovation. These contradictions and gaps motivate our seven-group factorization and the subsequent hypothesis testing and validation.

To strengthen the conceptual grounding, we locate the identified factors within established theoretical frameworks such as Resource-Based View, Dynamic Capabilities Theory, Institutional Theory, and Diffusion of Innovation Theory, which are commonly used in open-innovation research (Peñarroya-Farell and Miralles, 2021; Yun et al., 2020; Choi and Yoo, 2022; Zhang and Wang, 2021; Kiseleva et al., 2022). From a resource-based view, internal human and organizational assets and capability-centric drivers, such as employees' education, motivation, training, attitudes, organizational strategy, and strategy-aligned decision making, an innovation-supportive culture, management practices, and in-house R&D, constitute firm-specific resources and complementary assets whose configurations (building, deployment) underpin innovation performance (Peñarroya-Farell and Miralles, 2021; Yun et al., 2020). In dynamic capabilities terms, the assets' portfolio spans sensing (knowledge spillovers from investors, industry peers, other industries, conferences, and higher education), seizing (strategy-based decision-making, explicit knowledge/innovation goals), and reconfiguring (training, motivation, communication routines that enable process and organizational change) of assets to support renewal and innovation (Teece et al., 1997). Institutional Theory perspectives explain the externally oriented pressures and boundary conditions, such as urban location, export destinations, and competition intensity, as field-level constraints and incentives (coercive, normative, mimetic) that vary across contexts, shaping firm innovation choices (Choi and Yoo, 2022). Finally, diffusion-of-innovation logic is reflected in communication and training channels such as management communication, in-service training, conferences/exhibitions, and employees' attitudes toward change, which condition adoption of innovation within firms and across networks (Zhang and Wang, 2021) and in knowledge-spillover mechanisms such as peer exchange, cross-industry learning, conferences/exhibitions, and also in internal two-way communication, that structure information flows, perceived advantages, and adoption patterns (Kiseleva et al., 2022). Anchoring the factors in these frameworks clarifies which drivers are resource- and capability-based versus context- and adoption-driven, and it motivates our factor grouping, hypotheses, and AHP-weighted equations used to assess a company's readiness to innovate.

2.2. Defining the hypotheses

Based on the systematic literature review results and considering the factor grouping, the authors define 27 hypotheses. The list below presents these hypotheses, their respective sources identified through the SLR, and the underlying rationale. All hypotheses are formulated with an expected positive effect on innovation. Where the SLR reports contradictory or context-dependent findings (e.g., firm size and age;

alternative knowledge channels (customer/supplier vs. cross-industry/higher-education/investors); exporting and competition; and funding), these factors are tested in parallel across product, process, organizational, and overall innovations. This design allows us to adjudicate competing claims and, with AHP weighting and organization readiness equation validation, quantify their relative importance for CTI in a circular-economy setting.

H1.1. Urban location positively affects innovation (Djoumessi et al., 2019; Wang et al., 2020). Rationale: Urban centres increase knowledge flow and market contacts and reduce R&D costs. Geographical proximity facilitates market contact between companies and the dissemination of knowledge and labour, thus reducing the costs of R&D and the commercialization of innovation.

H1.2. A larger company size positively affects innovation (Afful, 2010; Djoumessi et al., 2019; Koberg et al., 2003; Yang et al., 2010). Rationale: Larger firms leverage scale, resources, and excess capacity, including technological innovation. There is a positive correlation between firm size and innovation capacity. Larger firms innovate more to utilize excess capacity and have an advantage in introducing technological innovations.

H1.3. Older company age positively affects innovation (Koberg et al., 2003). Rationale: As firms age, excess capacity often arises, and introducing innovation becomes a means to utilize this capacity.

H1.4. Higher salaries for blue-collar workers positively affect innovation (Wei et al., 2019). Rationale: Higher salaries increase employee enthusiasm and motivation, contributing more to innovation.

H1.5. A higher salary for white-collar workers positively affects innovation (Wei et al., 2019). Rationale: Similar to the above, for skilled professionals. Higher salaries motivate skilled professionals to support innovation initiatives actively. The higher the total level of salary is, the greater the employee's enthusiasm for the job and the greater the ability to help the company with innovation.

H2.1. The education (master's degree) of white-collar workers positively affects innovation (Berné-Martínez et al., 2021; Bailey and Sandy, 1999). Rationale: An educated workforce supports organizational innovation. Employees with higher education levels enhance a company's innovative capacity, as their involvement is vital in various innovation processes. Human capital is a key determinant of technological and organizational advancement, although the strength of this link can vary by national context.

H2.2. Regular in-service training positively affects innovation (Odei and Novak, 2020; Eusebio and Andreu, 2005; Sivalogathan, 2016; Lapina et al., 2017). Rationale: Skill development is critical for innovation. Investing in employee training enhances adaptability, strengthens innovation capabilities, and supports productivity, especially in SMEs.

H2.3. Hiring qualified employees positively affects innovation (Akinwale et al., 2018; Pourmojib and Godfrey, 2019). Rationale: Skilled staff enhance process innovation. Highly educated, technically skilled, and experienced employees from diverse backgrounds increase a company's capacity for innovation, particularly by initiating and supporting process improvements that require specific expertise and adaptability.

H2.4. Employees' attitude toward change positively affects innovation (Kutlu et al., 2020). Rationale: Employees are essential in the innovation process, and their attitude towards the change processes in the company is critical. Employee decisions and behaviour are important in the

innovations that take place in the company.

H3.1. The presence of a business strategy positively affects innovation (Feng and Ma, 2020; López-Cabarcos et al., 2020). Rationale: Strategic alignment enables innovation. Strategic consistency ensures that innovation efforts are aligned with the company's overarching goals. When integrated with a business strategy, an innovation strategy supports a long-term orientation, strengthens commitment to knowledge, and enhances the creation and dissemination of innovative outputs.

H3.2. Decision-making based on strategy positively affects innovation (Feng and Ma, 2020; López-Cabarcos et al., 2020). Rationale: Strategy-driven decisions are innovation-enabling. Strategic decision-making supports effective innovation by guiding choices that are aligned with long-term objectives. This coherence improves innovation outcomes, enhances knowledge flow, and ensures that actions contribute meaningfully to sustained innovation performance.

H3.3. Innovative culture positively affects innovation (Kutlu et al., 2020; Moussa et al., 2018; Padilha and Gomes, 2016; Suwignjo et al., 2022). Rationale: Culture fosters collective innovation efforts. A strong organizational culture encourages shared innovative thinking and collaborative problem solving. A supportive physical and psychosocial environment increases performance, whereas cultural dimensions such as individualism and collectivism are especially influential for process innovation.

H4.1. In-house R&D positively affects innovation (Srimarut and Mekhum, 2020; Zhang et al., 2020). Rationale: Internal R&D boosts tailored innovation. In-house R&D increases product innovation prospects, enables firms to lead the process, and provides more control and relevance than market- or collaboration-based research.

H4.2. External R&D services positively affect innovation (Adegbite, 2012; Akinwale et al., 2018; Dubickis and Gaile-Sarkane, 2021; Khyareh et al., 2019; Odei and Novak, 2020). Rationale: Outsourced expertise supports knowledge expansion. External R&D fosters knowledge creation and diffusion, strengthens technological capabilities, and supports innovation in firms lacking internal resources, although investment levels may vary by context.

H5.1. The intention to acquire new knowledge and technologies positively affects innovation (Aileni et al., 2020; Gomes et al., 2015). Rationale: Emphasizing knowledge fuels innovation. Organizations prioritizing acquiring knowledge and technologies are better equipped to drive product and process innovation.

H5.2. Innovation as a strategic goal positively affects innovation (Aileni et al., 2020; Gomes et al., 2015). Rationale: Direction and focus boost innovation. Integrating innovation into strategic goals demonstrates a commitment to continuous learning.

H5.3. Employee motivation positively affects innovation (Feng and Ma, 2020; Aschehoug et al., 2019; Tajeddini and Martin, 2020; Koberg et al., 2003; Kim et al., 2018). Rationale: Motivated staff contribute innovative ideas. Managerial openness, flexibility, trust-building, and tolerance for failure encourage idea generation, risk-taking, and introducing new solutions across organizational levels.

H5.4. Communication with employees positively affects innovation (Feng and Ma, 2020; Aschehoug et al., 2019; Tajeddini and Martin, 2020; Koberg et al., 2003; Kim et al., 2018). Rationale: Clear and transparent communication strengthens innovation by facilitating the exchange of ideas, aligning teams with strategic goals, and enabling faster adaptation to change through collaborative problem-solving and knowledge sharing.

H6.1. Exports to postindustrial countries positively affect innovation (Eusebio and Andreu, 2005; Afful, 2010; Wadho and Chaudhry, 2018). Rationale: Exporting firms face greater demands and competition, which pushes them to innovate. Export activity also encourages investment in

technology and strengthens international competitiveness.

H6.2. Competition positively affects innovation (Wang et al., 2020; Yadav and Saini, 2016; Khyareh et al., 2019; Montalvo et al., 2011; Wadho and Chaudhry, 2018; Sivalogathan and Wu, 2015; Kipkosgei and Paul, 2019; Chen et al., 2017). Rationale: Competition stimulates innovation by pressuring firms to differentiate, improve efficiency, and respond quickly to market demands. While they can sometimes strain resources, competitive environments often encourage greater investment in technology and the development of new products or processes.

H7.1-H7.7 Knowledge spillover (Feng and Ma, 2020; Srimarut and Mekhum, 2020; Chen et al., 2017; Bommel, 2016; Gomes et al., 2015; Ju and Lee, 2020; Sivalogathan and Wu, 2015; Nicoleta, 2014). Rationale: Knowledge exchange with customers, suppliers, institutions, and peer firms builds innovation capacity by enhancing employee capabilities, responding to market needs, and fostering collaboration. These interactions improve technological and nontechnological innovation, support adaptation to change, and help companies anticipate demand shifts, particularly when driven by customer value and supplier involvement. The external inputs support technological and nontechnological innovation, enhance adaptability and diverse insights, and add long-term value to the organization's innovation capacity.

H7.1. The knowledge gained from customers positively affects innovation. Rationale: Customer needs drive innovation.

H7.2. The knowledge gained from suppliers positively affects innovation. Rationale: Suppliers provide input and technical support.

H7.3. The knowledge gained from investors positively affects innovations. Rationale: Investors contribute strategic insight.

H7.4. The knowledge gained from other companies in the industry positively affects innovation. Rationale: Horizontal knowledge sharing enhances capacity.

H7.5. The knowledge gained from companies in other industries positively affects innovation. Rationale: Diverse insights promote innovation.

H7.6. The knowledge gained from exhibitions and conferences positively affects innovations. Rationale: Exposure to new ideas drives innovation.

H7.7. The knowledge gained from educational and research institutions positively affects innovations. Rationale: Academic linkages support R&D and innovation.

Factors not hypothesized: the hypothesis for quality management is not proposed, as it overlaps conceptually with knowledge gained from customers, for which a hypothesis has already been developed. While Ferreira and Cardoso (2014) present quality management as an innovation driver that helps meet customer expectations, it is considered to be indirectly addressed. Regarding government policy, Bartle et al. (2020) and Demircioglu and Audretsch (2017) emphasize its dual role as an enabler or barrier, especially in infrastructure and radical innovation. Sivalogathan and Wu (2015) suggest that policy can support innovation by reducing barriers and enhancing networks. Eusebio and Andreu (2005) underline the importance of local cooperation but note that it is insufficient alone. As companies cannot directly influence policy, no hypothesis is formulated. Odei and Novak (2020) find that funding does not guarantee SMEs' innovation, which sometimes has adverse effects. Huergo and Moreno (2014) distinguish effects across soft loans and subsidies. Berné-Martínez et al. (2021) stress the need for national innovation funding. Pourmojib and Godfrey (2019) link funding shortfalls to weak textile innovation. As financing relates mainly to R&D, it is covered under those hypotheses. Risk is not hypothesized, as some forms (e.g., force majeure) are uncontrollable. Hossain and Nagai (2019) and Abubakar (2014) highlight firms' fear of failure and poor risk management as innovation deterrents. For the market, Chuang (2009) and

Ferreira and Cardoso (2014) show that market signals influence innovation investment, whereas Dissanayake and Wijayasiri (2008) and Rosendo and Scheffer (2015) emphasize trade and supply chain integration. These are covered under competition and knowledge hypotheses. Market turbulence (Feng and Ma, 2020) and innovation protection (Peralta et al., 2016) are excluded because of external uncontrollability. Finally, while cooperation is linked to innovation by Berné-Martínez et al. (2021), Kim et al. (2018), and others, Akinwale et al. (2018) reported contrasting results. Since cooperation overlaps with knowledge spillover, no separate hypothesis is proposed.

2.3. Defining the dependent variables

To fully establish the groundwork for further empirical research, mainly to test the hypotheses, the authors, based on the systematic review of the scientific literature, also determined the performance indicators or dependent variables crucial for the subsequent assessment of the readiness of clothing and textile companies to introduce innovations. The dependent variables functional dimensions of innovations were set based on the principles of implementing the circular economy in CTI, primarily according to the definitions of the OSLO Manual on innovation and its types (OECD/Eurostat, 2018): product innovations, process innovations, and organizational innovations. Each type of innovation is further broken down into the principles of implementing the circular economy in the CTI, which are used as parameters in the companies' survey questionnaire (questions 30–46 in the questionnaire of the companies' survey in Appendix F). The survey results of these parameters are further used within the correlation analysis to test the hypotheses.

Process innovations:

1. Reduced use of toxins (Brismar, 2021; Close the Loop, 2021; Muthu, 2018; Saha et al., 2021);
2. Reduced use of water and energy in the production process (Close the Loop, 2021; Muthu, 2018; Saha et al., 2021);
3. Increased use of renewable energy in the production process (Close the Loop, 2021; Muthu, 2018; Saha et al., 2021);
4. More efficient production (Brismar, 2021; Muthu, 2018);
5. Reduced waste (Close the Loop, 2021; Muthu, 2018; Saha et al., 2021);
6. The production of more durable products with a long life cycle (Close the Loop, 2021; Muthu, 2018);
7. Introduction of new technologies for production (Close the Loop, 2021; Muthu, 2018);
8. Introduced computer programs for 3D modelling, weaving, or knitting (Close the Loop, 2021);
9. Introduction of readmission programs (Muthu, 2018).

Product innovations:

1. New products created with future product recycling in mind (Close the Loop, 2021; Muthu, 2018);
2. New products created using materials to make the product biodegradable (Close the Loop, 2021; Muthu, 2018);
3. New products created using recycled materials (Muthu, 2018);
4. New products created via residue-free trimming (Close the Loop, 2021; Muthu, 2018);

5. New products have been created using materials that extend the product's life cycle (Close the Loop, 2021; Muthu, 2018).

Organizational innovations:

1. A system has been set up to extend the longevity of products (e.g., product repair) (Close the Loop, 2021; Muthu, 2018);
2. The production of products according to individual measurements (parameters) has started (Muthu, 2018);
3. A matched supply with demand (Close the Loop, 2021; Muthu, 2018).

3. Methodology and research methods

The overall structure of the research methodology design consists of 7 consecutively constructed and implemented stages with the respective research and analysis methods; every next stage is built up relevantly to the results of the previous stages (Fig. 2).

The following empirical research methods are used to quantify the impact of the factors influencing innovation identified in the literature review:

The survey included the construction of a survey questionnaire and sampling of respondents (CTI companies). An online electronic survey was conducted via the Google Forms tool to obtain data from Latvia's clothing and textile companies. The largest Latvian companies in the clothing and textile industry were selected as respondents, and the NACE (Statistical Classification of Economic Activities) classification code was used to determine their compliance. The survey questionnaire, built on Google Forms, was distributed to respondents via e-mail. A total of 71 respondents took part in the survey; all questionnaires were included in processing the survey results via MS Excel and PSPP programs. The survey questionnaire (Appendix F) consists of 46 closed-ended questions, including multiple-choice questions and questions on a Likert scale. In accordance with the research design and methodology, all hypotheses and dependent variables were studied empirically via a survey with a questionnaire to evaluate the relationships between the identified innovation influencing factors and the dependent variables. Therefore, every question from 1 to 29 of the survey questionnaire was constructed on the basis of the SLR results in factor identification; each of the 27 identified factors influencing innovation, which are functionally grouped into seven groups, is built into parametric questions in the companies' survey questionnaire in 7 groups. The questions from 30 to 46 of the survey questionnaire were constructed by aligning them with the SLR results in defining the dependent variables—functional dimensions of innovations based on the principles of implementing the circular economy in CTI according to the definitions of the OSLO Manual on innovation and its types (OECD/Eurostat, 2018): product innovations, process innovations, and organizational innovations. Each principle of every type of innovation is constructed into parametric questions in the companies' survey questionnaire: Q30–38 for process innovations, Q39–43 for product innovations, and Q44–46 for organizational innovations. Likert-type and dichotomous scales were predominantly used to evaluate each question, allowing for consistent quantification and statistical comparison. The empirical sample of the survey comprises 71 CTI firms operating in Latvia. This size is adequate for detecting associations in correlation analysis; however, the single-country scope limits the external validity particularly of the

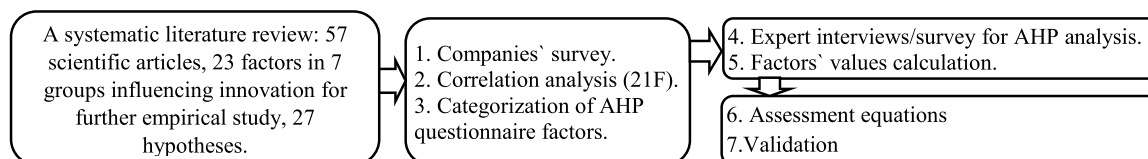


Fig. 2. The overall research methodology design scheme. Source: Developed by the authors.

quantified findings – the firm-level factor values and readiness scores. Accordingly, the quantifiable findings should be interpreted as context-specific to Latvia's CTI. At the same time, the assessment model's conceptual structure (factor set and grouping, derived from an international SLR) is transferable, but applications beyond Latvia should be accompanied by local data collection and recalibration of coefficients.

Correlation analysis was used to evaluate the relationship between two variables—the factors as independent variables and the performance indicators (types of innovation) as dependent variables. To assess the correlation between the factors, the analysis was performed in the PSPP program, an open-source statistical package analogous to SPSS. We chose PSPP to enhance transparency and reproducibility without compromising methodological equivalence for the routines used.

Construction of the analytical hierarchy process (AHP) questionnaire, sampling of respondents (experts), and expert assessment analysis. The AHP questionnaire determines the mutual significance of the groups of factors and the factors within each group included for introducing innovations. The AHP is a method used to solve complex and unstructured problems, where criteria and alternatives are grouped in a multilevel hierarchical structure (Talib et al., 2011). It was developed by Saaty (1987) to facilitate multicriteria decision-making, where the analytical (A) aspect suggests that the problem is divided into its constituent elements, and hierarchy (H) means that a hierarchy of constituent elements is listed for the main problem (objective), and process (P) indicates that data and judgments are processed to achieve the result. The results of the AHP survey were used to assign values to each factor, which was later used in the development of the assessment method and its assessment calculation equation. The AHP method consists of two significant phases (Bertolini et al., 2006): 1. Definitions of the hierarchical tree – determination of the proposed goal, group of factors, and determination of the factors included in it, based on the experience of experts and representation of known alternatives. 2. Numerical evaluation of the hierarchical tree – This stage is based on comparing pairs, where the criteria are compared at one level to determine their relative importance. A simplified version of the AHP is used for the empirical part of the study – the subfactors are compared only with the corresponding factors within the group and not with all the factors influencing the innovations. We used a simplified AHP design with pairwise comparisons within each factor group rather than across all factors to reduce respondent burden and cognitive load, and increase response quality for a mixed practitioner-researcher panel. This design prioritizes feasibility but does not elicit all cross-group pairwise judgments, preserving the relative prioritization within groups while maintaining acceptable consistency ($CR=0.06$), indicating reliable judgments, and aligns with streamlined AHP guidance for managerial decision contexts. To mitigate limitations and bias, we estimated group weights separately from factor weights, normalized weights so that factors within each group sum to 1, and group weights across groups sum to 1, and proportionally recalculated weights when factors without statistically significant correlations were excluded from a given innovation type, preserving internal coherence of the model.

After creating a hierarchy structure, experts must be involved in evaluating values. For the sampling of AHP survey respondents, experts who have had direct contact with the introduction of innovations and managers of innovative clothing and textile companies have been selected and invited to participate in the AHP survey; the experts were addressed from companies (NACE compliant) participating in the survey (company managers in CTI) as well as from the universities (innovation researchers). The experts' evaluations of the factors are critical in this article because, from the assessments given by the experts, the coefficients were used to create equations and determine the company's readiness to innovate in the context of the circular economy. When selecting experts, their previous experience in innovation research was considered. Moreover, when choosing companies, it was necessary to represent both clothing and textile companies and be on the list of 140

companies that are especially important for the Latvian economy. A total of 30 experts 15 innovation researchers, and 15 managers of clothing and textile companies were addressed for objectivity. Owing to the experts' busy schedules, the questionnaire was sent by e-mail and completed in writing. Among the experts surveyed or interviewed, 11 innovation researchers and six managers of clothing and textile companies responded to the call to complete the AHP questionnaire. The sample size of 17 experts well exceeds the methodologically and statistically required minimum of 6–8 experts (Saaty, 2015; Ulrich and Eppinger, 2012), suggesting that with this amount, a representative sample size of experts is met, providing 80–90 % of the expected information outcome. The AHP experts panel is nationally bounded (Latvia); therefore, some selection bias cannot be ruled out despite exceeding common AHP guidance on panel size. Accordingly, the derived group and factor weights quantitatively should be viewed as panel-specific to Latvia's institutional and market conditions. We recommend re-running the AHP with local experts and recalibrating the weights for applications in other countries or subsectors.

The task of the experts is to assess each of the factors' group subfactor pairs, assigning them a numerical value. The reason subfactors are compared first is the need for experts to become acquainted with the composition of all groups of factors before deciding on the impact of factors on the goal. The results then show the most critical factors and the subfactors necessary for their implementation. The following scale, with values ranging from 1 to 9, is used to compare factors and subfactors (Leal, 2020). The scale values show the comparative level of importance of one factor over the other, with the number 1 indicating that both factors are equally important in achieving the goal and nine meaning that one factor is immeasurably more important than the other: 1 – both factors are considered equally important; 3 – the chosen factor is moderately more important than the second factor; 5 – the chosen factor is more important than the second factor; 7 – the chosen factor is significantly more important than the second factor; 9 – the factor chosen is immeasurably more important than the second factor.

Design of the method to assess clothing and textile companies' readiness to innovate in the context of a circular economy. The assessment method results in the authors' designed equations, which are developed structurally in four consecutive steps: 1. Find which factors correlate with the specific type of innovation based on data analysis from the companies' survey processed through the PSPP program; 2. Coefficients for groups and factors included in AHP questionnaires are obtained based on expert assessments; 3. Recalculate the coefficients according to the included/excluded factors and groups; 4. Make the equations.

Validation. The validation method involves selecting company survey responses based on the number of introduced innovations, low, average, and high. The readiness coefficient calculated via the developed equations is compared with the reported number of innovations for each selected case. This enables a structured check of the method's consistency and applicability across different innovation levels.

4. Results

4.1. Survey and correlation analysis

In accordance with the research design and methodology, all hypotheses were studied empirically via a survey with a questionnaire (Appendix F) to evaluate the relationships between the identified innovation influencing factors and their dependent variables, which are different types of innovations. Of the 27 hypotheses postulated and empirically tested, six were rejected, and 21 were confirmed fully or partially, indicating the multifaceted nature of innovation drivers in ICT and revealing that not all of the assumed positive effects from the scientific literature translate directly into practical outcomes in this sector. The empirical results of hypothesis testing (correlation analysis) reveal a nuanced understanding of the factors influencing innovation and their

Table 2
Correlation of company parameter factors with different types of innovations.

N#	1 st group Company parameters` factors (hypotheses` codes)/Types of innovation	A	B	C	D
1	Company location (urban centre) (H1.1)	0.23	0.21	0.04	0.45**
2	Company size (H1.2)	No significant correlation			
3	Company age (H1.3)	No significant correlation			
4	Salaries of blue-collar workers (H1.4)	0.33**	0.32**	0.15	0.29*
5	Salaries of white-collar workers (H1.5)	No significant correlation			

Note: *Correlation is significant at the 0.05 level (two-tailed). **Correlation is significant at the 0.01 level (two-tailed). A – introduction of any innovation; B – introduction of process innovations; C – introduction of product innovations; D – introduction of organizational innovations.
Source: Developed by the authors based on survey results.

Table 3
Correlation of employee factors with different types of innovations.

N#	2 nd group Employees` factors (hypotheses` codes)/Types of innovation	A	B	C	D
6	Education level for white-collar workers (H2.1)	0.21	0.18	0.08	0.27*
7	In-service training for employees (H2.2)	0.36**	0.35*	0.27*	0.06
8	Filled vacancies with skilled workforce (H2.3)	No significant correlation			
9	Employee attitude toward change processes (H2.4)	0.25*	0.24*	0.23	0.16

Note: *Correlation is significant at the 0.05 level (two-tailed). **Correlation is significant at the 0.01 level (two-tailed). A – introduction of any innovation; B – introduction of process innovations; C – introduction of product innovations; D – introduction of organizational innovations.
Source: Developed by the authors on the basis of survey results.

Table 4
Correlation of organizational strategy and culture factors with different types of innovations.

N#	3 rd group Organizational Strategy and Culture factors	A	B	C	D
10	Existence of a long-term strategy (H3.1)	0.44**	0.48**	0.26*	0.19
11	Decisions in the company are made based on a long-term strategy (H3.2)	0.42**	0.44**	0.26*	0.2
12	Innovative company culture (H3.3)	0.24*	0.18	0.29*	0.09

Note: *Correlation is significant at the 0.05 level (two-tailed). **Correlation is significant at the 0.01 level (two-tailed). A – introduction of any innovation; B – introduction of process innovations; C – introduction of product innovations; D – introduction of organizational innovations.
Source: Developed by the authors based on survey results.

Table 5
Correlation of research and development factors with different types of innovations.

N#	4 th group Research and Development factors (hypotheses` codes)	A	B	C	D
13	In-house R&D (H4.1)	0.48**	0.45**	0.28*	0.36**
14	Purchase of external research services (H4.2)	0.42**	0.34**	0.32**	0.30**

Note: *Correlation is significant at the 0.05 level (two-tailed). **Correlation is significant at the 0.01 level (two-tailed). A – introduction of any innovation; B – introduction of process innovations; C – introduction of product innovations; D – introduction of organizational innovations.
Source: Developed by the authors based on survey results.

Table 6
Correlation of management factors with different types of innovations.

N#	5 th group Management factors (hypotheses` codes)/Types of innovation	A	B	C	D
15	The importance of the goal – to acquire new knowl. & technol. (H5.1)	0.34*	0.39**	0.24*	0.14
16	The importance of the goal of innovation (H5.2)	0.45**	0.38**	0.41**	0.15
17	Measures to increase employee motivation (H5.3)	0.38*	0.37**	0.37**	0.14
18	Informing employees about the strategy and changes (H5.4)	0.30*	0.26*	0.24*	0.26*

Note: *Correlation is significant at the 0.05 level (two-tailed). **Correlation is significant at the 0.01 level (two-tailed). A – introduction of any innovation; B – introduction of process innovations; C – introduction of product innovations; D – introduction of organizational innovations.
Source: Developed by the authors based on survey results.

Table 7
Correlation of export and competition factors with different types of innovations.

N#	6 th group Export and competition factors (hypotheses` codes)	A	B	C	D
19	Export groups of countries (H6.1)	0.31**	0.33**	0.19	0.2
20	Intensity of competition (H6.2)	0.14	0.06	0.23*	-0.06

Note: *Correlation is significant at the 0.05 level (two-tailed). **Correlation is significant at the 0.01 level (two-tailed). A – introduction of any innovation; B – introduction of process innovations; C – introduction of product innovations; D – introduction of organizational innovations.

Source: Developed by the authors based on survey results.

Table 8
Correlation of knowledge spillover factors with different types of innovations.

N#	7 th group Knowledge spillover factors (hypotheses` codes)	A	B	C	D
21	Knowledge gained from customers (H7.1.)	No significant correlation			
22	Knowledge gained from suppliers (H7.2.)	No significant correlation			
23	Knowledge gained from investors (H7.3.)	0.27*	0.28*	0.17	0.04
24	Knowledge gained from other companies in the industry (H7.4.)	0.29*	0.29*	0.34**	0.01
25	Knowledge gained from companies in other industries (H7.5.)	0.29*	0.32**	0.31**	0.02
26	Knowledge gained from conferences and exhibitions (H7.6.)	0.38**	0.37**	0.33**	0.08
27	Knowledge gained from higher education and research institutions (H7.7.)	0.20	0.11	0.28*	-0.01

*Correlation is significant at the 0.05 level (two-tailed). **Correlation is significant at the 0.01 level (two-tailed). A – introduction of any innovation; B – introduction of process innovations; C – introduction of product innovations; D – introduction of organizational innovations.

Source: Developed by the authors based on survey results.

statistical correlation with various types and principles of innovation in the CTI in the context of a circular economy (Tables 2–8), allowing conclusions of their socioeconomic meanings to be drawn.

Table 2 shows that hypothesis H1.1 (urban location) is partially confirmed, with a significant correlation only with organizational innovations. This reflects how geographical proximity in urban centres can support innovation through enhanced market contact and institutional coordination. However, the lack of correlation with product and process innovations suggests that proximity alone is insufficient without accompanying innovation structures. In contrast, hypotheses H1.2 and H1.3 (company size and age) are rejected, indicating that neither scale economies nor accumulated capacity automatically fosters innovation in CTI. This challenges prior assumptions that larger or older firms have greater innovation output due to excess capacity or established knowledge structures; in this case, agility and adaptability may outweigh legacy advantages. H1.4 and H1.5 (blue- and white-collar wages) present contrasting outcomes: H1.4 is partially confirmed, showing a significant positive correlation with process and organizational innovations, supporting the rationale that fair wages for blue-collar workers increase employee enthusiasm and motivation, which in turn enhance engagement with innovation processes, particularly those targeting efficiency and manufacturing quality. In contrast, H1.5 (white-collar wages) is rejected. It does not show a significant correlation with any type of innovation, indicating that while compensation may motivate operational staff, a wage increase alone for skilled professionals does not increase innovation.

Table 3 shows that hypothesis H2.1 (education of white-collar workers) is partially confirmed, correlating with organizational innovation and affirming the hypothesis that higher education levels improve a company’s capacity to innovate, especially in structuring and managing organizational changes. H2.2 (in-service training) is partially confirmed. A correlation with process and product innovations proves that regular skill development enhances employee adaptability, technical competence, and the capacity to support manufacturing practices and sustainable product development. H2.3 (hiring skilled employees) is rejected, indicating that the presence of technically skilled and

experienced personnel alone does not significantly influence innovation outcomes in CTI. This challenges the assumption that employee qualifications directly drive innovation capacity, suggesting instead that it must be integrated into broader organizational processes, training systems, or cultural frameworks to have an impact, including that the process improvements depend not only on expertise but also on internal coordination and innovation-supportive structures. H2.4 (employee attitude toward change) is partially confirmed, as it is correlated with process innovations and the overall innovation set. This finding supports the rationale that employees play an essential role in innovation and that their attitude toward change processes within the company is critical. Positive employee behaviour and openness to change directly influence adopting new practices, particularly those needed for process improvements.

Table 4 shows that hypothesis H3.1 (the existence of a long-term business strategy) is partially confirmed, showing a correlation with product and process innovations and the overall innovation set. This finding supports the idea that a clear, long-term strategy helps align innovation efforts with company goals, particularly in product improvement and manufacturing efficiency. However, its limited link to organizational innovation suggests that strategy alone may not drive internal structural changes. H3.2 (strategy-based decision-making) is partially confirmed, with correlations observed for product and process innovations and the overall innovation set. This finding supports the rationale that when company decisions align with long-term strategic goals, they foster innovation by improving coherence, focus, and knowledge flow. The absence of a link to organizational innovation suggests that decision alignment alone may not trigger internal transformation. H3.3 (innovative company culture) is partially confirmed and is correlated with process innovations and the overall innovation set. This finding supports the idea that a collaborative and supportive culture fosters innovation, particularly in improving processes. Its limited impact on other innovation types suggests that culture plays a stronger role at the operational level.

Table 5 shows that both hypotheses of this group, H4.1 and H4.2 (in-house and external R&D), are fully confirmed, showing strong

correlations with all types of innovation. These results support the view that internal and external R&D are critical drivers of innovation in CTI. In-house R&D enables firms to lead innovation with greater control and relevance, whereas external R&D provides access to specialized knowledge and technologies. Together, they strengthen innovation capacity across product, process, and organizational dimensions.

Table 6 shows that hypotheses H5.1 and H5.2 (importance of acquiring knowledge and innovation as a goal) of the management factor group are partially confirmed, showing a correlation with product and process innovations and the overall innovation set. These results support the view that emphasizing knowledge acquisition and setting innovation as a strategic objective strengthens a company's capacity to innovate in areas closely tied to technology and manufacturing. However, their limited impact on organizational innovation suggests that strategic intent alone may not lead to internal structural or managerial change. H5.3 (employee motivation) is also partially confirmed, showing a correlation with product, process, and overall innovation but not with organizational innovation. This finding supports the view that motivated employees – encouraged by managerial openness, trust, and tolerance for failure – will likely contribute ideas and engage in experimentation. The absence of a link to organizational innovation suggests that employee motivation at a company is not a driver of structural or managerial changes. H5.4 (communication with employees) is fully confirmed—a factor correlated with all innovation types. The results confirm that the importance of transparent and consistent communication in aligning teams, enabling knowledge sharing, and fostering collaboration are key conditions for successful innovation throughout the organization.

Table 7 shows that hypothesis H6.1 (exports to postindustrial countries) is partially confirmed, with a correlation between product innovations and the overall innovation set. This finding supports the rationale that exposure to international markets encourages companies to innovate, particularly in product development, to meet higher standards and strengthen global competitiveness. The absence of a correlation with the process and organizational innovation suggests that exporting does not foster internal operational or structural changes. H6.2 (competition) is partially confirmed, with a correlation observed only for product innovation. This finding supports the view that competitive pressure can stimulate firms to develop new or improved products to maintain their market position. However, the absence of a correlation with process and organizational innovation suggests that competition may not consistently encourage broader innovation efforts or internal efficiency improvements in the CTI context.

Table 8 shows that the 7th group's knowledge spillover hypothesis testing results are mixed, showing that not all knowledge sources equally support innovation in CTI. The hypotheses that knowledge gained from customers (H7.1) and suppliers (H7.2) positively affects innovation are rejected. Despite their assumed roles—customer knowledge as a key driver of product development and supplier input as a contributor to technical advancement and service design—knowledge gained from both sources did not appear to influence innovation outcomes in the CTI context, suggesting that their input may be underutilized, insufficiently integrated, or disconnected from the internal innovation process. H7.3 (knowledge gained from investors) is partially confirmed, with a positive correlation between process innovation and overall innovation. This finding supports the rationale that investor input contributes strategic insight, helping guide operational improvements and innovation-related decision-making. While not influencing all innovation types, investor knowledge enhances internal capabilities, particularly in areas tied to efficiency and introduction. H7.4, H7.5, and H7.6 (knowledge gained from other companies in the industry,

companies in other industries, and exhibitions and conferences) are all partially confirmed, showing correlations with product, process, or overall innovation. These results suggest that peer exchange, cross-sector learning, and exposure to new ideas contribute meaningfully to innovation in CTI. Finally, the knowledge gained from educational and research institutions (H7.7) is partially confirmed, with a positive correlation only with product innovation, highlighting the role of academic collaboration in technical development. The absence of this knowledge source correlation with process and organizational innovations suggests that academic knowledge is not yet fully leveraged across the broader innovation spectrum in CTI companies. Additionally, the consistent lack of correlation with organizational innovations across all knowledge spillover hypotheses suggests that while external knowledge sources may support product and process innovation, they are not systematically integrated into the management or structural processes of CTI companies.

After the correlation analysis, the factors influencing innovation in the clothing and textile sector are reset, leaving 21 factors in 7 groups for further development of the method for assessing the readiness of clothing and textile companies to introduce innovations (Fig. 3).

In summary, the correlation analysis confirmed 21 of the 27 proposed hypotheses, highlighting that innovation in the clothing and textile industry is shaped by a multifaceted set of factors rather than by any single determinant. The strongest drivers identified were internal and external R&D activities, transparent management communication, and long-term strategic orientation, all of which significantly correlate with multiple forms of innovation. Employee-related aspects, such as regular training, openness to change, and fair wages for blue-collar workers, were also found to support innovation, particularly in processes and organizational improvements. External influences, including international market exposure, competition, and knowledge flows from industry peers, other sectors, and research institutions, further reinforced innovation capacity, primarily in product and process development. In contrast, company size, age, or knowledge from customers and suppliers showed no significant effect.

Six of the 27 hypothesized drivers showed no significant correlation with any innovation type in our data – firm size, firm age, white-collar wages, unfilled vacancies (shortage of skilled staff), and knowledge from customers and suppliers. Three straightforward reasons may explain this: first, most Latvian CTI firms are small and often work as subcontractors, so differences in size/age are limited and scale effects are weak; second, the way we measured some items captures levels rather than how they are used (e.g., pay range but not incentive design; a vacancy snapshot but not how actively firms build skills), which can dilute observable links; third, customer/supplier knowledge may act with a delay and often arrives as compliance or cost pressure, such effects a cross-sectional survey may miss so that these inputs may be underused or they also may not be well integrated into innovation work in ICT firms in Latvia.

4.2. Expert assessment (AHP)

In accordance with the research design and methodology, the statistically significant factors influencing innovation in the clothing and textile industry and their groups were further given to the experts, managers of clothing and textile companies, and innovation researchers, to quantify the evaluations of the factors and their groups. Their values were calculated based on the AHP assessment results (Table 9).

For interrater reliability, the consistency of expert judgments was assessed via the consistency ratio (CR), which was calculated via Saaty's method as the ratio of the consistency index (CI) to the random index

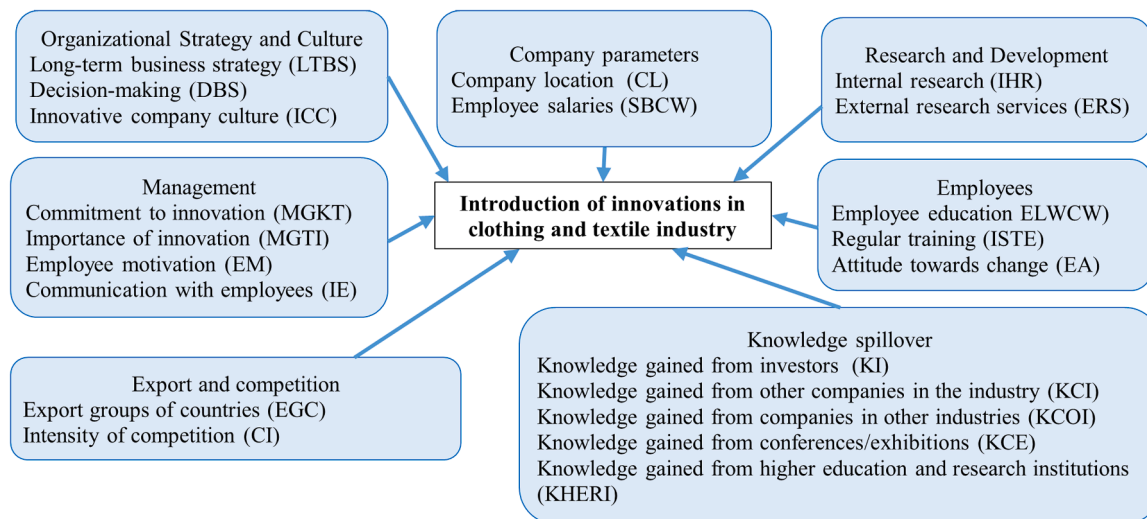


Fig. 3. Factors influencing innovation. Source: Developed by the authors based on hypothesis correlation analysis.

Table 9
Experts' evaluations of the factors and their groups were used to calculate values.

Group	Factors coded*	Average weights	Calculated FACTOR WEIGHTS per innovation type**				Calculated GROUP WEIGHTS per innovation type**			
			A (any)	B (proc.)	C (prod.)	D (org.)	A (any)	B (proc.)	C (prod.)	D(org.)
1. Company parameters	1. CL	0.36				0.36	0.06	0.06	No cor.	0.10
	2. SBCW	0.64	1	1		0.64				
2. Employees	3. ELWCW	0.18				1	0.14	0.14	0.15	0.24
	4. ISTE	0.30	0.37	0.37	1					
	5. EA	0.52	0.63	0.63						
3. Organizational Strategy and Culture	6. LTBS	0.16	0.16	0.5	0.16		0.14	0.14	0.15	Nocorrelation
	7. DBS	0.16	0.16	0.5	0.16					
	8. ICC	0.68	0.68		0.68					
4. R&D	9. IHR	0.65	0.65	0.65	0.65	0.65	0.23	0.23	0.25	0.40
	10. ERS	0.35	0.35	0.35	0.35	0.35				
5. Management	11. MGKT	0.12	0.12	0.12	0.12		0.15	0.15	0.16	0.26
	12. MGTI	0.12	0.12	0.12	0.12					
	13. EM	0.43	0.43	0.43	0.43					
6. Export and competition	14. MC	0.33	0.33	0.33	0.33	1				
	15. EGC	0.40	1	1			0.10	0.10	0.11	No cor.
	16. CI	0.60			1					
7. Knowledge spillover	17. KI	0.17	0.20	0.20			0.18	0.18	0.19	Nocorrelation
	18. KCI	0.21	0.25	0.25	0.25					
	19. KCOI	0.22	0.26	0.26	0.26					
	20. KCE	0.24	0.29	0.29	0.29					

Note: CL – Company location. SBCW – Salary of blue-collar workers. ELWCW – Education level of white-collar workers. ISTE – In-service training for employees. EA – Employees' attitude toward change in the company. LTBS – Company's long-term business strategy. DBS – Decisions are made based on strategy. ICC – Innovative company's culture. IHR – In-house research. ERS – External research services. MGKT – Management goal to acquire knowledge and technology. MGTI – Management goal to innovate. EM – Employees' motivation. MC – Management communication with employees. EGC – Export groups of countries. CI – Competition intensity. KI – Knowledge gained from investors. KCI – Knowledge gained from companies in the industry. KCOI – Knowledge gained from companies in other industries. KCE – Knowledge gained from conferences/exhibitions. KHERI – Knowledge gained from higher education and research institutions. ** A – Any type of innovation. ** B – Process innovations. ** C – Product innovations. ** D – Organizational innovations.

Source: Developed by the authors based on AHP survey results.

(RI). In this study, the CI was 0.054, and the RI for the AHP matrix size was 0.90, resulting in a CR of 0.06, which is well below the threshold of 0.10, confirming a high level of internal consistency and reliability in the expert evaluations.

Factors of Group 1 – company parameters. Based on the AHP assessments by innovation researchers and managers of clothing and textile companies, the average calculated weights (importance levels) of the factors within the 1st group are 0.36 for company location (CL) and 0.64 for the salary level of blue-collar workers (SBCW). These values are further used and recalculated according to the correlation analysis results. For example, for types A and B innovations, only one factor within the group showed a statistically significant correlation. Thus, its weight for A- and B-type innovations within the group is 1, whereas for D-type innovations, both factors within the group are significantly correlated. Thus, their average AHP values are used further in the assessment equation, totaling 1. The experts assess the importance (weight) of Group 1 among all seven groups of factors as the least essential setting, with an average value of 0.06 out of 1.

Factors of Group 2 – employees. The most crucial factor of the group is employees' attitude (EA) toward change in the company, with an average value of 0.52 based on AHP evaluations by innovation researchers and managers. The second most crucial factor within the group is employees' professional development via the company's in-service training for employees (ISTE), with a factor average value of 0.3. Finally, the last employee-related factor of Group 2, with an average value of 0.18, is education level (master's degree) for white-collar workers (ELWCW). As the ELWCW factor did not show statistically significant correlations with A- and B-type innovations, but the ISTE and EA factors did, the values of the ISTE and EA factors for the further assessment equations for A- and B-type innovations are recalculated proportionally, ISTE to 0.37 and ISTE to 0.63 together, totaling 1. Similarly, the ISTE and ELWCW factors are the only factors that are statistically significantly correlated with the C and D types of innovations, respectively. Thus, their values for the assessment equations for the C and D types of innovations are recalculated to 1. Overall, Group 2, among all seven groups of factors, is assessed by experts in the middle of the seven groups, with a group value of 0.14 out of 1, which shares the same rank and value as Group 3.

Factors of Group 3 organizational strategy and culture. The innovative company culture (ICC), with an average value as high as 0.68 out of 1, was distinctly determined by experts as the most critical factor. The other two factors the company's long-term business strategy (LTBS) and the decision-making based on that strategy (DBS) were assessed on average as equal to 0.16. All three groups' factors showed statistically significant correlations with types A and C innovations. Thus, these values are used further for the assessment equations for A- and C-type innovations, whereas for the B-type innovations, only two factors (LTBS and DBS) show statistically significant correlations; thus, their values for the assessment equations for the B-type innovations are recalculated proportionally to 0.5 because they have the same average values of 0.16. None of the group factors showed statistically significant correlations with D-type innovations; thus, they are not used further in the assessment equation for D-type innovations. Among all seven groups of factors, Group 3 is assigned a value of 0.14.

Factors of Group 4 – research and development. Among the two statistically significant factors of the group, the in-house research (IHR) factor is considered considerably more important than outsourcing external research services (ERS), with average calculated values of 0.65 IHR and 0.35 for ERS. These factors showed statistically significant correlations with all types of innovations; thus, these values should be used further for the assessment equations. Overall, this group of factors is assessed as the most important among all seven factors, with a calculated importance level (weight) value of 0.23.

Factors of Group 5 – management. Among the four statistically significant factors of the 5th group, the most critical factor, with an average value of 0.43, was employee motivation (EM), which was supported by

companies' implemented measures to increase employee motivation. The second most crucial factor in this group is management communication with employees (MC), which means that employees are informed about the company's strategy or changes in the company. The calculated average value of this factor within the group is 0.33. The remaining two factors in this group management commitment to innovation, showing how important a goal for management is to acquire new knowledge and technologies (MGKT), and management goal to innovate (MGTI), demonstrating the importance of a management goal to innovate with new products, technologies, and methods, were equally evaluated, with average values of 0.12. All of the group factors showed statistically significant correlations with types A, B, and C innovations. Thus, these values are used further for the assessment equations for A-, B-, and C-type innovations, whereas for D-type innovations, only the MC factor shows a statistically significant correlation; thus, its value for the assessment equation for D-type innovations is reassigned to 1. The weight of all the factors in Group 5 is assessed to be 0.15, ranking this group as the 3rd most crucial group of factors influencing innovation among all seven groups of factors.

Factors of Group 6 – Export and competition. Out of the two factors of the group, competition intensity (CI) was assessed as a more critical factor than the groups of countries where exports take place (EGC), with average values of 0.6 and 0.4, respectively. Given that only EGC showed statistically significant correlations with A- and B-type innovations and that only CI showed a statistically significant correlation with C-type innovations, each factor value for the respective assessment equations was reassigned to 1. Neither of the two factors showed statistically significant correlations with D-type innovations; thus, they are not used further in the assessment equation for D-type innovations. Among all seven groups of factors, Group 6 is assessed to have a value of 0.10, ranking the group of export and competition factors as the 2nd least important group of factors influencing innovations after Group 1 factors of company parameters.

Factors of Group 7 – knowledge spillover. The assessed weight values of factors in this group were distributed closely among top 3 and 0.24 for knowledge gained from conferences/exhibitions (KCE), 0.22 for knowledge gained from companies in other industries (KCOI), and 0.21 for knowledge gained from other companies within the industry (KCI), followed by lower values for knowledge gained from investors (KI) and from knowledge gained from higher education and research institutions (KHERI), both 0.17. These values are further slightly recalculated with respect to the correlation analysis results, as only 4 out of 5 factors showed statistically significant correlations with A- and B-type innovations (KI 0.2, KCI 0.25, KCOI 0.26, and KCE 0.29), and one-factor-different sets of 4 out of 5 factors also showed statistically significant correlations with C-type innovations (KCI 0.25, KCOI 0.26, KCE 0.29 and KHERI 0.2). As neither of the two factors again showed statistically significant correlations with D-type innovations, they are not further used in the assessment equation for D-type innovations. Overall, this group of knowledge spillover factors is assessed as the 2nd most important among all seven groups of factors, with a calculated importance level (weight) value of 0.18.

All group assessments: Group 4 research and development factors are assessed as the most important group of factors with a weight value of 0.23, followed by Group 2 knowledge spillover factors with an average weight value of 0.18 and Group 5 management factors with an average weight value of 0.15, which is just 0.01 higher than all groups' median and mode the average weight value of 0.14 for Groups 2 and 3 employee factors and organizational strategy and culture factors. The least important group of factors influencing innovations is the Group 1 factor of company parameters, with an average group weight value of 0.10 out of 1. All the groups' values together total 1. Like with the individual factors, the group values are, where necessary, recalculated based on the results of correlation analysis, e.g., as the Group 1 Company parameters factors showed no statistically significant correlation with C-type innovations and Groups 3, 6, and 7 showed no statistically significant

correlation with D-type innovations, the other group values for the C- and D-type innovations assessment equations are recalculated proportionally with all the represented groups together totaling 1.

In summary, the expert evaluation highlights research and development as the most influential group of factors for fostering innovation in the clothing and textile industry, with in-house R&D particularly critical. Knowledge spillovers, especially those derived from conferences, inter-industry collaboration, and peer exchange, were also emphasized as necessary, followed by management-related factors such as employee motivation and effective communication. Employee attitudes toward change and continuous training, alongside an innovative organizational culture, were identified as supportive elements, though with comparatively lower weights. Conversely, company parameters and export-related factors were ranked as least important.

4.3. Development of a method for assessing readiness to introduce innovations

Equations for different types of innovations are developed using the results obtained in the study to assess the company’s readiness to introduce innovations in the context of a circular economy in the clothing and textile industry. For each type of innovation and for all innovations together, a formula was created where the factors to be included were those for which a statistically significant correlation was found with the respective innovation group. In contrast, the individual factor value coefficients were calculated on the basis of the AHP expert survey questionnaire results. Appendix G contains the extract of the survey questionnaire for companies with statistically significant factor questions, answer options, and quantified values.

The formulation of the equations consisted of several methodological (systematic) steps:

- 1) Identification of factors influencing innovations (based on SLR) and further identification of statistically significant factors on the basis of companies’ survey (Appendix F) and correlation analysis;
- 2) Defining the values of the statistically significant factors. The values are derived on the basis of the companies’ survey from the respective questions/answers and are generally set from 0 to 1 in deciles (0; 0.1; 0.2; 0.3; 0.9; 1), quintiles (0; 0.2; 0.4; 0.6; 0.8; 1), quartiles (0; 0.25; 0.5; 0.75; 1), tertiles (0; 0.33; 0.66; 1) or full values (0; 1) –Appendix G;
- 3) Obtain weights for each factor and group of factors on the basis of AHP assessments by experts;
- 4) Proportionate recalculation of values and weights of the factors and their groups with respect to correlation analysis results means that if a factor has not shown a statistically significant correlation with one of the performance indicators, such factors should not be used for the respective equations; thus, other factors in the group are proportionately recalculated with higher values. This ensures the consequent quantification of results, with each group of factor values totaling one and all similar groups’ weights totaling one.

- 5) Creating an equation allowing for quantified calculation of readiness, considering the values and weights of the respective statistically significant correlation factors and their corresponding groups.

Thus, the equations are developed on the basis of the following formula principle (Eq. (1)):

$$\begin{aligned}
 [\text{Type of innovation}]readiness &= G1w(F1v * F1v + F2w * F2v + \dots + F\#w \\
 &\quad * F\#v) + G2w(F1w * F1v + \dots + F\#w \\
 &\quad * F\#v) + G\#w(F1w * F1v + \dots + F\#w \\
 &\quad * F\#v)
 \end{aligned}
 \tag{1}$$

where G#w is the respective factor group weight (based on AHP assessments by experts); F#w is the respective factor weight (based on AHP assessments by experts); and F#v is the respective factor value (based on company survey results).

For practical application of the equation formula (for total innovation and/or for any of the three specific types of innovation), the groups’ and factors’ weights (G#w and F#w) can be used as calculated in this research (Eqs. 2–5 with the weights already provided). In contrast, the respective factor value (F#v) at a particular company can be calculated (self-assessed at the company) by using the companies’ survey questionnaire (Appendix F, questions 1–29) and the provided assessment scale of each factor (Appendix G). The obtained values of each factor can be further input into Eqs. 2–5 (replacing the factor abbreviations with the value number) to calculate the company’s readiness to innovate level. The computed result in each of the equations can vary from 0 to 1, where zero would indicate that a company is not ready to introduce innovations in the general or the respective dimension, and one would suggest the company’s full potential to introduce innovations. The example of practically calculated results is further presented in section 4.4 and Fig. 4.

In total, four equations were created: the 1st equation for innovations in general, regardless of their type (Eq. 2); the 2nd equation for process innovations (Eq. 3); the 3rd equation for product innovations (Eq. 4); and the 4th equation for organizational innovations (Eq. 5).

$$\begin{aligned}
 \text{Total innovation readiness(17factors in7groups)} &= \text{Group10.06} * (1\text{SBCW}) + \text{Group20.14} \\
 &\quad * (0.37\text{ISTE} + 0.63\text{EA}) + \text{Group30.14} \\
 &\quad * (0.16\text{LTBS} + 0.16\text{DBS} + 0.68\text{ICC}) + \text{Group40.23} \\
 &\quad * (0.65\text{IHR} + 0.35\text{ERS}) + \text{Group50.15} \\
 &\quad * (0.12\text{MGKT} + 0.12\text{MGTI} + 0.43\text{EM} + 0.33\text{MC}) + \text{Group60.10} \\
 &\quad * (1\text{EGC}) + \text{Group70.18} \\
 &\quad * (0.20\text{KI} + 0.25\text{KCI} + 0.26\text{KCOI} + 0.29\text{KCE})
 \end{aligned}
 \tag{2}$$

where SBCW represents the salaries of blue-collar employees; ISTE

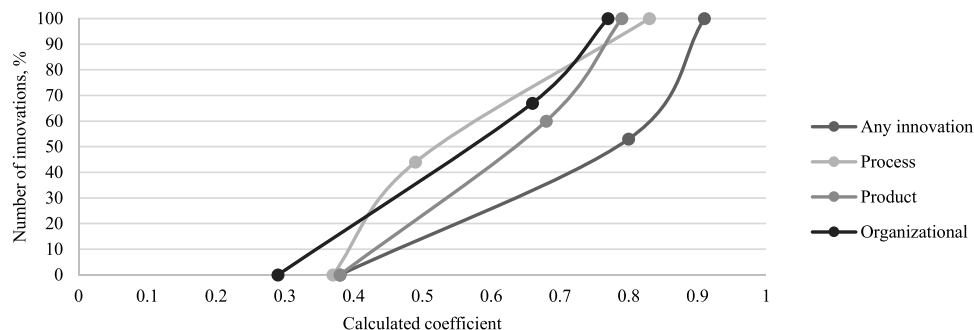


Fig. 4. Validation of the equations: companies’ indicated number of innovations in % and the calculated coefficients for all and each type of innovation. Source: Developed by the authors on the basis of the study results.

represents in-service training for employees; EA represents employees' attitude towards change processes; LTBS represents the existence of a long-term business strategy; DBS represents decisions made on the basis of long-term strategy; ICC represents innovative company culture; IHR represents in-house research; ERS represents the purchase of external research services; MGKT represents management goals to acquire knowledge and technology; MGTI represents management goals to innovate; EM represents measures to increase employee motivation; MC represents management communication to employees; EGC represents groups of countries for exports; KI represents knowledge gained from investors; KCI represents knowledge gained from other companies in the industry; KCOI represents knowledge gained from companies in other industries; and KCE represents knowledge gained from conferences and exhibitions.

Following the same principle, the equation of the company's readiness to introduce process innovations in the context of a circular economy was created (Eq. 3):

$$\begin{aligned}
 & \text{Process innovation readiness}(16\text{factors in}7\text{groups}) \\
 & = \text{Group}10.06 * (1\text{SBCW}) + \text{Group}20.14 \\
 & * (0.37\text{ISTE} + 0.63\text{EA}) + \text{Group}30.14 \\
 & * (0.5\text{LTBS} + 0.5\text{DBS}) + \text{Group}40.23 \\
 & * (0.65\text{IHR} + 0.35\text{ERS}) + \text{Group}50.15 \\
 & * (0.12\text{MGKT} + 0.12\text{MGTI} + 0.43\text{EM} + 0.33\text{MC}) + \text{Group}60.10 \\
 & * (1\text{EGC}) + \text{Group}70.18 \\
 & * (0.20\text{KI} + 0.25\text{KCI} + 0.26\text{KCOI} + 0.29\text{KCE})
 \end{aligned} \tag{3}$$

where SBCW represents the salaries of blue-collar employees; ISTE represents in-service training for employees; EA represents employees' attitude towards change processes; LTBS represents the existence of a long-term business strategy; DBS represents decisions made on the basis of long-term strategy; ICC represents innovative company culture; IHR represents in-house research; ERS represents the purchase of external research services; MGKT represents management goals to acquire knowledge and technology; MGTI represents management goals to innovate; EM represents measures to increase employee motivation; MC represents management communication to employees; EGC represents groups of countries for exports; KI represents knowledge gained from investors; KCI represents knowledge gained from other companies in the industry; KCOI represents knowledge gained from companies in other industries; and KCE represents knowledge gained from conferences and exhibitions.

Following the same principle, the equation of the company's readiness to introduce product innovations in the context of a circular economy was created (Eq. 4):

$$\begin{aligned}
 & \text{Product innovation readiness}(15\text{factors in}6\text{groups}) \\
 & = \text{Group}20.15 * (1\text{ISTE}) + \text{Group}30.15 \\
 & * (0.16\text{LTBS} + 0.16\text{DBS} + 0.68\text{ICC}) + \text{Group}40.25 \\
 & * (0.65\text{IHR} + 0.35\text{ERS}) + \text{Group}50.16 \\
 & * (0.12\text{MGKT} + 0.12\text{MGTI} + 0.43\text{EM} + 0.33\text{MC}) + \text{Group}60.11 \\
 & * (1\text{CI}) + \text{Group}70.19 \\
 & * (0.25\text{KCI} + 0.26\text{KCOI} + 0.29\text{KCE} + 0.20\text{KHERI})
 \end{aligned} \tag{4}$$

where ISTE is in-service training for employees. LTBS – existence of a long-term business strategy; DBS – decisions made on the basis of long-term strategy; ICC – innovative company culture. IHR – in-house research; ERS – purchase of external research services; MGKT – management goal to acquire knowledge and technology; MGTI – management goal to innovate; EM – measures to increase employee motivation; MC – management communication to employees; CI – competition

intensity; KCI – knowledge gained from other companies in the industry; KCOI – knowledge gained from companies in other industries; KCE – knowledge gained from conferences and exhibitions; KHERI – knowledge gained from higher education and research institutions.

The equation for organizational innovation (Eq. 5):

$$\begin{aligned}
 & \text{Organizational innovation readiness}(6\text{factors in}4\text{groups}) \\
 & = \text{Group}10.10 * (0.36\text{CL} + 0.64\text{SBCW}) + \text{Group}20.24 \\
 & * (1\text{ELWCW}) + \text{Group}40.40 \\
 & * (0.65\text{IHR} + 0.35\text{ERS}) + \text{Group}50.26 * (1\text{MC})
 \end{aligned} \tag{5}$$

where: CL – company location; SBCW – salary of blue-collar workers; ELWCW – education level of white-collar workers; IHR – in-house research; ERS – external research services; MC – management communication with employees.

4.4. Validation of a method for assessing readiness to introduce innovations

To verify the performance of each of the developed equations, three questionnaires were selected from the survey filtered by the indicated number of innovations (questions 30–46 in the questionnaire of the companies' survey in Appendix F). The questionnaires were selected as follows: one questionnaire (company) with the lowest indicated number of total innovations (2 out of 17), one with an average number of total innovations (9 out of 17), and one with the highest indicated number of innovations (17 out of 17). Similarly, three questionnaires were selected from the survey for each type of innovation: B – process, C – product, and D – organizational innovations. For each of the chosen companies (questionnaire), the number of innovations was further compared with the calculated coefficient on the basis of the developed equation, indicating the company's readiness to innovate in the circular economy context. The results of such a comparison allowed for precise observation of each type of innovation (Fig. 4), and as the number of innovations increases, the coefficient obtained by calculations using data from the questionnaire also increases. For example, in the case of a total number of innovations, a company that had introduced 2 out of 17 innovations obtained a readiness coefficient of 0.38; a company with 9 out of 17 innovations introduced had a readiness level of 0.80; and for a company that had introduced 17 innovations, the calculated readiness coefficient was 0.91.

The graph below shows the companies' indicated number of innovations and the calculated coefficients for all and each type of innovation. The number of innovations has been estimated to share in % for comparable quantified interpretation; in absolute numbers, there are 17 innovations in total, including nine process innovations, 5 product innovations, and three organizational innovations.

Fig. 4 shows that all innovations and each type of innovation show an upward trend. The coefficient calculated according to the formula is greater for those companies that have introduced more innovations, which shows that the factors, their values, and weights correlate with the greater performance of innovations in the context of the circular economy. Thus, the developed methodology with the assessment equations can be used to assess the readiness of companies to introduce innovations in the context of the circular economy.

5. Discussion

In this study, the authors explored seven factorized groups that, after several iterations, included 21 statistically significant factors influencing innovations in the circular economy, focusing on the clothing and textile industry. Articles that have examined many factors affecting innovation in the clothing and textile industry simultaneously were not found while doing this research, as most existing studies focus on 2–4 factors, e.g., management or employees as a factor. The factors in

this study are more specific and comprehensively grouped than those in most of the articles and thus include more explicit results. We first situate our findings within prior literature based on the conducted SLR and then state the conclusions supported directly by their data (Tables 2–9; Fig. 4), followed by concluding practical managerial takeaways.

Company parameters. Prior literature based on SLR shows mixed effects of company parameters: older firm age can hinder product innovation because younger companies have to secure their position in the market, whereas older companies usually have a stable customer base (Afful, 2010); larger company's size is often expected to enable innovation via scale (Koberg et al., 2003); organizational innovation has been linked to age and size (Dubickis, 2021); urban location may support innovation through knowledge flows (Djoumessi et al., 2019; Wang et al., 2020); and higher salaries are argued to affect innovation positively (Wei et al., 2019). Our data-based results (Table 2), however, show that firm size, age, and white-collar wages have no significant correlation with any innovation type. At the same time, urban location correlates only with organizational innovation. An important conclusion is that the most relevant factor among the statistically significant factors in this group is the blue-collar wage: it was supported by the SLR (Wei et al., 2019; Gomes et al., 2015), and data show it correlates positively with process and organizational innovations (Table 2) and was also rated most relevant by experts (Table 9). Interpreted through Herzberg's lens (Tan et al., 2013), pay is a hygiene factor: adequate wages support engagement with operational change, but higher salaries for professionals alone do not raise innovation.

Employees. The SLR results highlight learning orientation and training as enablers of innovation in CTI (Yoh, 2009; Sivalogathan, 2016; Lapina et al., 2017); link formal education to organizational change (Dubickis, 2021); place the hiring of qualified (skilled) employees among fostering factors for innovation (Akinwale et al., 2018; Pourmojib and Godfrey, 2019), and identify employees' attitude toward change as a driver of innovation (Kutlu et al., 2020), though the attitude factor has not been sufficiently studied specifically for clothing and textile firms. Our data (Table 3) specify that in-service training correlates with – and is therefore crucial for – process and product innovations, consistent with the view that a shared vision and commitment to learning determine textile firms' innovation capabilities. By contrast, our results did not show the correlation between in-service training and organizational innovation reported by Dubickis (2021). In this study, a correlation with organizational innovation might not be shown due to the comparatively small number of organizational innovations captured in the survey. Employees' attitude toward change correlates with process and overall innovation and was rated the most critical factor by experts (Table 9), whereas the share of white-collar staff with a master's degree correlates only with organizational innovation; shortages of skilled staff show no significant correlation with any type of innovation. Consistent with these patterns, experts' AHP assessments show the highest weight to employees' attitude, followed by in-service training and education level of white-collar employees (Table 9), reinforcing that capability-building and openness to change underpin operational and product improvements. In contrast, formal education mainly supports organizational change.

Organizational strategy and culture. SLR results indicated that a long-term strategy and strategy-based decision-making enable innovation by aligning the company's tactical performance with long-term objectives (Feng and Ma, 2020; López-Cabarcos et al., 2020). Both articles underline the need for a clear strategic vision to introduce innovations and sustain employee motivation in various ways (responsibility, meaningful work, involvement in decision making, etc.). Other studies likewise stress the critical role of future-oriented vision (Aileni et al., 2020; Gomes et al., 2015; Yoh, 2009). Similarly, prior literature also emphasizes that an innovation-supportive culture fosters collaborative problem-solving (Padilha and Gomes, 2016; Moussa et al., 2018; Gomes et al., 2015). Our data (Table 4) show that the existence of

a long-term strategy and decision-making based on that strategy both correlate with process and product innovations (and with overall innovation). In contrast, the innovative culture correlates with product and overall innovation but not process and organizational innovations. Although Gomes et al. (2015) reported stronger links of innovative culture to process innovation, our study revealed the opposite, with only innovative company culture affecting product innovations. Consistent with these correlations, experts' AHP evaluations (Table 9) prioritize innovative culture within this group (ICC = 0.68) over long-term strategy and strategy-based decision-making (each 0.16). These findings imply that firms should maintain a long-term strategy and ensure aligned decision-making in their day-to-day activities to support operational improvements and innovation efforts while deliberately cultivating an innovation-supportive culture to strengthen product innovation.

Research and development. SLR results consistently identified R&D as a core driver of innovation in CTI, with in-house efforts often having a more substantial impact than outsourced services because they more directly promote innovation performance (Zhang et al., 2020; Srimarut and Mekhum, 2020; Adegbite, 2012; Akinwale et al., 2018; Dubickis and Gaile-Sarkane, 2021). Dubickis (2021) found the association strongest for process innovation. Our data (Table 5) show that both in-house R&D and external research services correlate positively with all types of innovation, with the effects strongest for in-house R&D for process and overall innovation. At the same time, product and organizational innovations' correlations are also significant. Experts' AHP assessments assign the highest group weight to R&D (0.23), marking it the most critical factor affecting innovation in clothing and textile companies, and prioritize in-house over external activity (0.65 vs 0.35) (Table 9). Data from the survey show that only 42 % of the companies have conducted in-house research in the last 3 years, and even fewer companies (21 %) have outsourced research services. Such results imply that CTI companies should run a regular in-house R&D program and use external services to access specialized knowledge and accelerate innovation projects, such as technology pilots, process upgrades, new product development, and organizational change.

Management. SLR results identified four management factors affecting innovation: management commitment to innovation, including, a goal to acquire new knowledge and technologies, and innovation as a strategic goal (Aileni et al., 2020; Gomes et al., 2015), measures to increase employee motivation, and communication with employees about changing to the company as shared clear communication is essential for positive results (Feng and Ma, 2020; Aschehoug et al., 2019; Tajeddini and Martin, 2020; Koberg et al., 2003; Kim et al., 2018), with most studies linking these factors particularly to product and process outcomes in manufacturing contexts. Our data (Table 6) show a precise mapping of correlations: communication with employees correlates with all types of innovation, whereas the goals to acquire knowledge/technologies, the goal to innovate, and employee motivation correlate with process, product, and overall innovation but not with organizational innovation. For organizational innovation, only communication as a factor shows significance and thus is retained in the readiness assessment equation. Experts' AHP evaluations (Table 9) align with these patterns by assigning the highest within-group weight to employee motivation (0.43) and next to communication (0.33). At the same time, both managerial goals carry the in-group significance of 0.12. Together, the triangulation of data-based results imply that communication is the only management practice spanning all innovation types, while motivation and explicit goals channel effort more directly into technology-, process-, and product-focused improvements; accordingly, CTI firms should maintain two-way routine communication about strategy and change in company with company's employees, set explicit knowledge/innovation goals, and most critically embed concrete motivation mechanisms so that the managerial intent, through sustained employees' motivation, translates into measurable gains in process and product innovation while also supporting organization-wide

innovation alignment.

Exports and competition. SLR results link exporting, especially to advanced (post-industrial) markets, and competition intensity to more substantial innovation incentives, making a difference in innovation between companies that export and those that do not (Eusebio and Andreu, 2005; Afful, 2010; Wadho and Chaudhry, 2018; Montalvo et al., 2011; Yadav and Saini, 2016; Khyareh et al., 2019; Chen et al., 2017). Our data (Table 7) show that export destination correlates with overall and process innovation, whereas competition intensity correlates only with product innovation. Experts' via AHP place this as a lower-priority group (group weight of 0.10) with export destination affecting particularly process innovation (and innovation in general) and competition intensity factor retained for product innovation (Eqs. 2–4), and neither factor used for organizational innovation (Eq. 5). Practically, firms should leverage exports to post-industrial markets to drive process upgrades and compliance-driven improvements, treat competition primarily as a spur for product differentiation, and, given the lower group weight, prioritise R&D, management practices, and knowledge spillovers before reallocating resources to market-pressure levers.

Knowledge spillover. SLR results typically emphasise knowledge from customers and suppliers as key inputs to innovation in CTI and related manufacturing (European Commission, 2015; Rosendo and Scheffer, 2015; Chen et al., 2017; Gomes et al., 2015; Sivalogathan and Wu, 2015; Bommel, 2016; Ju and Lee, 2020), including the knowledge becoming an increasingly important factor of production (Dubickis et al., 2024). Our data (Table 8) diverge: customer- and supplier-derived knowledge show no significant correlation with any innovation type, while knowledge from investors correlates with process and overall innovation; knowledge from within the industry, from other industries, and from conferences/exhibitions correlates with product, process, and overall innovation; and knowledge from higher education and research institutions correlates only with product innovation. Innovation researchers consider higher education, research institutions, and investors the most essential sources of knowledge. In contrast, the same sources of knowledge were considered the least important by business leaders, and the survey results showed that knowledge is gained the least from these sources. Experts' AHP evaluations (Table 9) rank this group second among the seven (group weight is 0.18) and prioritise conferences/exhibitions, cross-industry learning, and peer exchange within the group. At the same time, investors and higher education as sources of knowledge would affect the process and product innovation accordingly. In practice, these results imply that CTI firms should prioritise within-industry and cross-industry networks and conference scouting, engage higher-education partners when targeting product innovation, and draw on investor insight for process improvements. Furthermore, given that customer- and supplier-derived knowledge show no significant correlations in our data (Table 8), suggesting these inputs are underutilized or insufficiently integrated, companies may need stronger mechanisms to capture and incorporate these sources of knowledge into innovation workflows.

Overall, the empirically significant factors align with a Dynamic Capabilities bundle: external and cross-industry knowledge flows and investor input reflect sensing; strategy-aligned decision-making and explicit knowledge/innovation goals reflect seizing; and in-house R&D, in-service training, two-way communication, and employee motivation reflect reconfiguring (Teecce et al., 1997). In parallel, the prominence of training and communication in our results is consistent with learning orientation and the acquisition, dissemination, and use of knowledge in CTI (Yoh, 2009; Sivalogathan, 2016; Lapina et al., 2017; Gomes et al., 2015). This anchoring helps explain why scale and age are non-significant here: advantage appears to stem less from static stocks (size, age) and more from the firm's rate of sensing, learning, and reconfiguring. The null effects for customer/supplier knowledge suggest a gap in capturing or internalizing boundary information into routine practice, reinforcing the need to strengthen learning channels alongside sensing activities.

Translating the SLR-grounded findings and our data-driven empirical correlation patterns into practice, we operationalize these relationships to develop a method to assess the company's readiness to innovate in the context of a circular economy in the clothing and textile industry (see Eqs. 2–5) and evaluate their alignment with observed innovation outcomes; as shown in Fig. 4, readiness coefficients rise consistently across all four innovation types as firms report more introduced innovations. This concordance supports the internal validity of the factor values and weights underpinning the equations. It demonstrates the methodological and practical utility of diagnosing organizational readiness to innovate in a circular economy. By completing the questionnaire and applying the equations, managers can identify high-leverage areas, allocate resources accordingly, and track progress over time. Because the organizational-innovation equation includes fewer factors and groups, each carries greater weight; moreover, the correlation patterns indicate that organizational innovation is partly driven by different factors than process and product innovation. Expanding the set of organizational-innovation indicators in future iterations would further improve measurement precision.

To sum up, the significance of the findings including in the correlation patterns across Tables 2–9 indicate that different innovation types in CTI manufacturing firms are enabled by distinct organizational and managerial mechanisms: R&D (primarily in-house) and selected knowledge spillovers provide the strongest lift overall; two-way managerial communication is the only practice that spans all innovation types; strategy-aligned decisions matter most for process and product change; culture connects more strongly to product innovation; and blue-collar wages relate to process/organizational change, underscoring the role of operational engagement. Equally important is what did not correlate: customer- and supplier-derived knowledge, suggesting an integration gap at firm boundaries. Conceptually, this points to a logic that firms should match the lever to the innovation type rather than seek one-size-fits-all drivers. Translating these patterns into action, the organization readiness model is a targeted diagnostic to prioritise high-leverage levers and guide capability building. By scoring current practices, firms can prioritise R&D, targeted spillovers, and communication before expending scarce resources on lower-weight domains (e.g., generic market pressure). The monotonic relationship in Fig. 4 provides convergent validity, meaning that higher computed readiness aligns with more introduced innovations, supporting using the developed assessment method for resource allocation, progress tracking, and capability building. Given the narrower set of organizational-innovation indicators, managers should interpret that dimension as conservative and consider augmenting measurement where organizational change is a primary target.

6. Conclusions

This study aimed to determine and examine the factors that affect innovation in the clothing and textile industry in four types of innovation – overall or any, process, product, and organizational. We tested 27 hypotheses and identified 21 statistically significant factors, grouped into seven business management perspective domains, that shape innovation outcomes; the factors are weighted based on expert assessments to reflect their relative importance, providing a sector-specific and empirically validated alternative to generic readiness frameworks. Across the seven domains, the results show that R&D (mainly in-house) and selected knowledge spillovers have the most substantial effect on innovation showing the most significant and most consistent correlations across innovation types and receiving the highest AHP group weights; two-way managerial communication is the only practice spanning all innovation types; strategy-aligned decision-making matters most for process and product change; culture is more strongly connected to product innovation; and blue-collar wages relate to process/organizational change, underscoring operational engagement. Export destination aligns with process (and overall) innovation, while competition

intensity aligns primarily with product innovation. Notably, customer- and supplier-derived knowledge did not correlate with any innovation type, indicating an integration gap at firm boundaries. Validation of the method shows a clear positive relationship: firms that report more introduced innovations also receive higher computed readiness scores, supporting the assessment model's validity. Managers can use the weights (importance levels) of factors and their groups as calculated and validated in this research. The company-specific values of each factor influencing innovation can be self-assessed internally via the authors' method, which includes specific survey questionnaires (Appendix F, Questions 1–29) and the accompanying assessment scale (Appendix G). By inputting these self-assessed values into the respective equations, companies can practically calculate their readiness level for total or specific innovation types. This readiness assessment allows managers to a) identify which areas (factors and groups) require improvement to enhance innovation capability and which can serve as the best practices in the industry; b) make empirical data-based decisions on where to allocate resources and training; and c) benchmark their readiness to innovate against industry standards or evaluate a company's innovation management progress over time. For policymakers, this tool can provide a structured framework to a) evaluate readiness to innovate across regions or subsectors within the textile industry and b) design targeted policy interventions, e.g., capacity building, fostering competitiveness, and innovation incentives based on the critical readiness gaps identified in the industry. Thus, the assessment model offers a practical and replicable operational and strategic decision-making method, fostering more innovation-oriented and competitive textile enterprises.

While tailored to the textile and clothing sector, the model is adaptable to other industries and outside of Latvia. Its alignment with circular-economy objectives, which demand innovative and practical transition solutions, makes it pertinent. While the assessment model does not encompass all possible factors, it is scientifically grounded, methodologically rigorous, validated, and replicable. Thus, it is applicable as a complementary management tool in real-world business settings. This model expands upon and examines in more detail the factor groups of the TOE framework (Tornatzky and Fleischer, 1990) and can be used complementarily with scales developed from the TOE framework (e.g., Zhu et al., 2004), as well as with the scales developed from the ACAP framework (e.g., Flatten et al., 2011). The authors designed an organizational readiness assessment model tailored to the clothing and textile industry and validated in Latvia, which is adaptable across sectors and regions globally. The model provides a scientifically grounded, data-based decision-making tool for managers and policymakers to assess and enhance the innovation capability of a company or sector within the circular economy framework. Its structure and the internationally relevant factors identified in the research make it especially useful for industries transitioning from traditional manufacturing to innovation-driven economies. With this study, the authors extend the assessment of organizational readiness to innovate to a sector-specific circular economy context.

Research limitations: The systematic literature review (SLR) of the scientific sources was limited to 4 databases Google Scholar, ScienceDirect, SpringerLink, and ResearchGate. While conducting the policy documentation search, the authors worked with the latest publications. The search keywords in the SLR were limited to combinations of factors-innovation-textile-apparel-clothing-industry, and the search subject areas included business, management, innovation, and manufacturing. The study also has the following content-wise restrictions: only process, product, and organizational innovations were studied in a circular economy, and only those factors directly or indirectly dependent on companies were studied in detail. Thus, marketing or consumer-side innovations are not covered, and exclusion criteria such as eco-innovation, green innovation, and innovation policies are used in the SLR. The geographically empirical scope of 71 CTI firms in the survey and 17 experts from Latvia in AHP supports correlation testing but

constrains external validity – for applications in other countries or subsectors, we recommend re-running the AHP with local experts and recalibrating the weights. The self-reported survey design limits causal inference and may be exposed to common-method variance despite anonymity and varied scale formats. The average results of the AHP questionnaire are considered for creating equations. The AHP was intentionally simplified (pairwise comparisons within groups only) to reduce respondent burden and cognitive load and increase response quality for a mixed practitioner-researcher panel. At the same time, consistency was acceptable (CR 0.06). This structure may introduce aggregation bias versus a whole hierarchy. Organizational innovation is measured with relatively few indicators, which can understate its relationships. Finally, PSPP was used for transparency and reproducibility; the results are method-equivalent to standard packages.

Suggestions for further research: The study can be continued by creating equations that consider only the results of innovation researchers and equations that consider only the results of questionnaires of managers of clothing and textile companies, including possible separate analyses for clothing vs. textile subsectors and SMEs vs. large-firm strata. Additionally, some factors need to be explored in more depth, such as the level of education. As previously emphasized, the authors defined a higher level of education as the frequency of master's degrees; however, more research is needed on the role of different levels of education in industry. Future work may also add validated multi-item scales, multi-source and longitudinal designs, sensitivity analyses (e.g., non-parametric/bootstrapped correlations), and a complete AHP hierarchy to strengthen reliability, validity, and generalizability.

CRediT authorship contribution statement

Mikus Dubickis: Writing – review & editing, Validation, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization. **Zane Hovlanne:** Writing – original draft, Visualization, Validation, Investigation, Formal analysis, Data curation. **Romans Putans:** Writing – review & editing, Validation, Methodology, Formal analysis.

Informed consent statement

Informed consent was obtained from all the subjects involved in the study.

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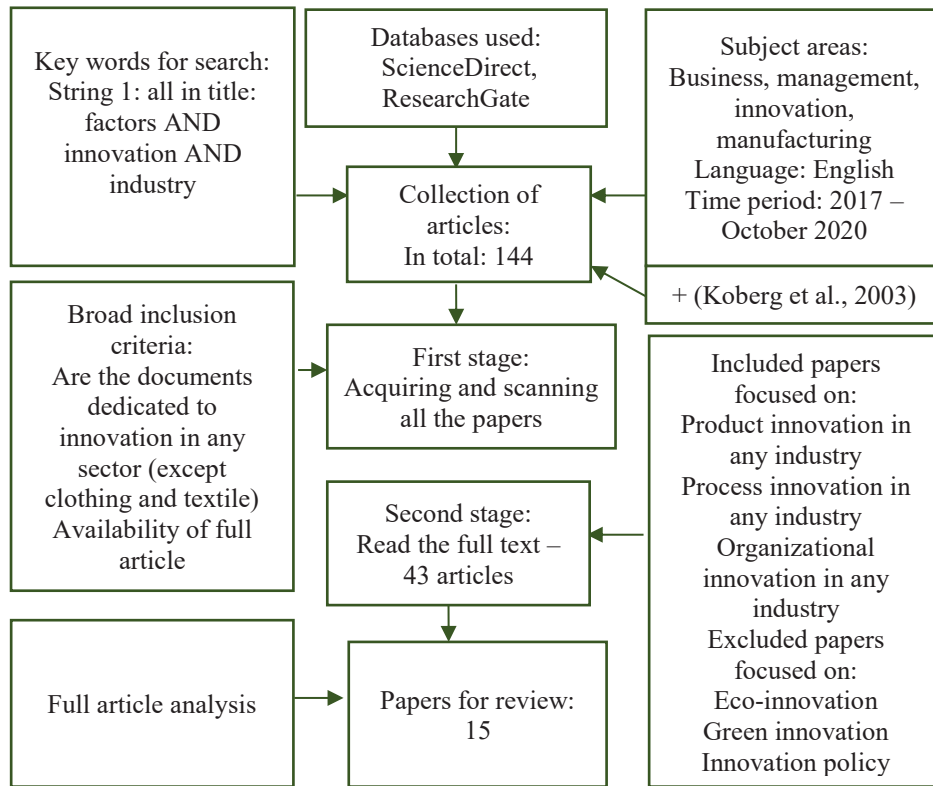
Declaration of Generative AI and AI-assisted technologies in the writing process

Authors declare that all text, analysis, data interpretation, conclusions, and other content presented in the article is the authors' original work, which has been produced solely by the authors and does not contain content generated by AI tools. Where any sources and references were used, they have been appropriately cited according to academic integrity standards.

Declaration of Competing Interest

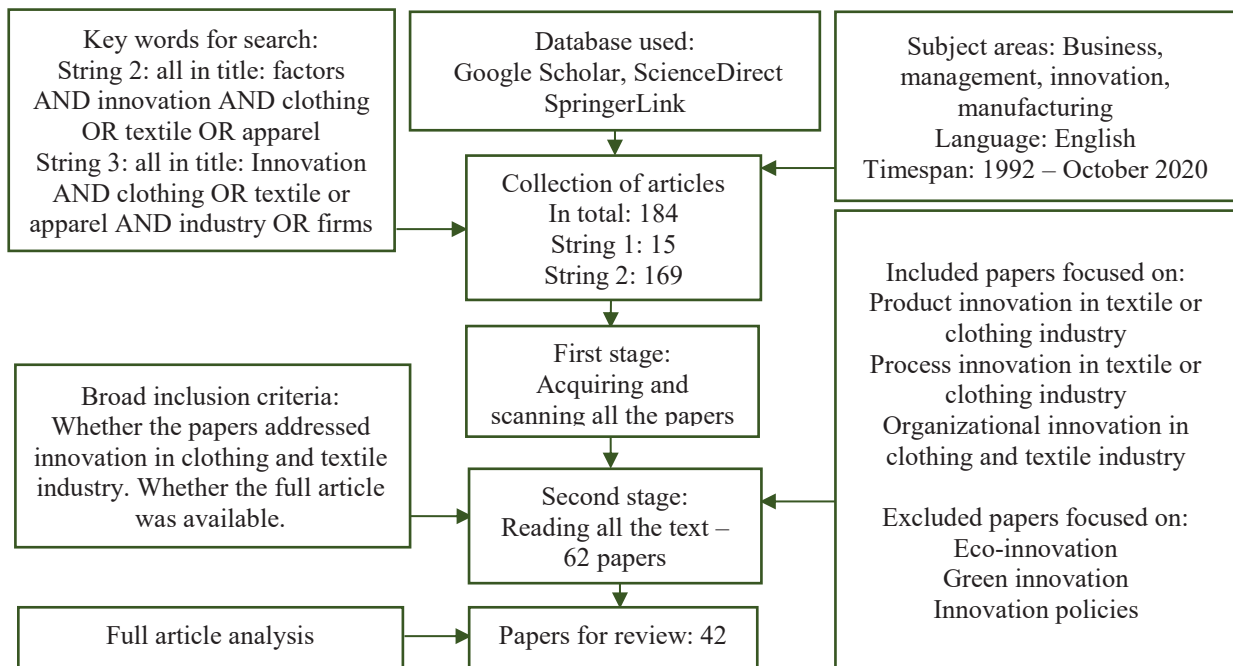
The authors declare that they have no conflicts of interest.

Appendix A. SLR design for innovation search in general (all sectors)



Source: Developed by the authors.

Appendix B. SLR design for innovation search in the clothing and textile industry (CTI)



Source: Designed by the authors.

Appendix C. Factors influencing innovation in general

Source	Factors																
	Employees	Research & development	Management	Financing	Cooperation	Organizational strategy	Knowledge spillover	Government policy	Competition	Company size	Organizational culture	Company location	Customer orientation	Customers age	Company age	Turmoil	Suppliers
Count	8	6	6	4	4	3	3	2	2	2	2	2	1	1	1	1	1
Akinwale et al. (2018)	x	x				x	x										
Aschehoug et al. (2019)		x	x					x		x							
Berné-Martínez et al. (2021)	x			x	x												
Chen et al. (2017)		x		x			x	x									
Demircioglu and Audretsch (2017)	x		x														
Djoumessi et al. (2019)		x							x	x		x					
Evan and Holý (2021)	x	x															
Feng and Ma (2020)	x		x			x	x				x		x	x		x	x
Kim et al. (2018)			x	x	x												
Koberg et al. (2003)			x												x		
López-Cabarcos et al. (2020)						x											
Moussa et al. (2018)			x			x					x						
Silva et al. (2019)	x	x		x	x												
Wang et al. (2020)	x								x			x					
Wei et al. (2019)	x																

Source: Compilation by the authors on the basis of the SLR.

Appendix D. Factors influencing innovation in the clothing and textile industry (Abubakar, 2014; Adegbite, 2012; Aileni et al., 2020; Bailey and Sandy, 1999; Bommel, 2016; Masi, 2020; Chen et al., 2017; Chuang, 2009; Coy et al., 1992; Dissanayake and Wijayasiri, 2008; Oeij et al., 2012; Eusebio and Andreu, 2005; Ferreira and Cardoso, 2014; Gomes et al., 2015; Gökmen and Hamgöğlü, 2011; Hanlon, 2012; Hoa et al., 2020; Hossain and Nagai, 2019; Jeon, 2018; Afful, 2010; Ju and Lee, 2020; Kipkosgei and Paul, 2019; Kocik and Higgs, 2020; Tian et al., 2018; Montalvo et al., 2011; Nicoleta, 2014; Padilha and Gomes, 2016; Pazilov et al., 2020; Peralta et al., 2016; Pourmojib and Godfrey, 2019; Rosendo and Scheffer, 2015; Muthu, 2018; Sivalogathan, 2016; Sivalogathan and Wu, 2015; Wadho and Chaudhry, 2018; Yadav and Saini, 2016; Yang et al., 2010; Yin, 2016; Yoh, 2009; Zhang et al., 2020; Giacosa, 2017)

Source	Factors																	
	Employees	Knowledge	Customers	Government policy	Market	Company size	Competition	Management	Organizational strategies	Economy	Organizational culture	Financing	Research & development	Export	Risk	Quality Management	Innovation protection	Company age
Count	14	11	10	10	9	7	7	6	6	6	4	4	3	3	3	1	1	7
Abubakar (2014)				x											x			
Adegbite (2012)	x			x									x					
Aileni et al. (2020)								x				x						
Bailey & Sandy (1999)	x					x												
Bommel (2016)		x																
Masi (2020)			x	x														
Chen et al. (2017)			x		x		x								x			
Chuang (2009)					x													
Coy et al. (1992)	x							x										
Dissanayake & Wijayasiri (2009)					x													
Oeij et al. (2012)	x				x					x								
Eusebio & Andreu (2005)	x			x										x				
Ferreira & Cardoso (2014)					x											x		
Gomes et al. (2015)	x	x						x	x									
Gökmen & Hamgöğlü (2011)		x																
Hanlon (2012)										x								
Hoa et al. (2020)		x																
Hossain & Nagai (2019)			x												x			
Jeon (2018)	x	x							x									
Afful (2010)	x					x								x				x
Ju & Lee (2020)			x															
Kipkosgei & Paul (2019)						x	x											
Kocik (2020)		x						x										
Tian et al. (2018)	x										x							
Montalvo et al. (2011)			x	x			x					x						
Nicoleta (2014)		x						x										
Padilha & Gomes (2016)						x					x							
Pazilov et al. (2020)												x						
Peralta et al. (2016)	x		x		x												x	
Pourmojib & Godfrey (2019)	x	x		x		x												
Rosendo & Scheffer (2015)			x	x	x							x	x					
Muthu (2018)			x				x											
Sivalogathan (2016)			x		x		x			x								
Sivalogathan & Wu (2015)		x		x					x	x								
Wadho & Chaudhry (2018)		x		x		x	x							x				
Yadav & Saini (2016)	x		x				x	x										
Yang et al. (2010)						x				x								
Yin (2016)					x													
Yoh (2009)	x								x		x							
Zhang et al. (2020)				x									x					
Giacosa (2017)								x	x	x	x							

Source: Compilation by the authors on the basis of the SLR.

Appendix E. SLR counts the results of factors influencing innovation

N	Factor	SLR-1 Source count (non-CTI specific). N = 15	SLR-2 Source count (specific in CTI). N = 41	N	Factor	SLR-1 Source count (non-CTI specific). N = 15	SLR-2 Source count (specific in CTI). N = 41
1	Employees	8	14	13	Customer orientation	1	None
2	R&D	6	3	14	Management	6	6
3	Customers	1	10	15	Company age	1	1
4	Financing	4	4	16	Turmoil	1	None
5	Cooperation	4	None	17	Suppliers	1	None
6	Organizational strategy	3	6	18	Market	None	9
7	Competition	2	7	19	Export	None	3
8	Government policy	2	10	20	Economy	None	6
9	Knowledge spillover	3	11	21	Quality Management	None	1
10	Company size	2	7	22	Risk	None	3
11	Organizational culture	2	4	23	Innovation protection	None	1
12	Company location	2	None				

Source: Authors made on the basis of the SLR results.

Appendix F. Companies' survey questionnaire design and methodology (scales)

Category	Question	Scale used
1. Company parameters	1. Industry	Respondents indicate the industry to which the enterprise belongs depending on the type of activity (NACE classification)Clothing industryTextile industryClothing and textile industry
	2. Company age	Respondents indicate the year of foundation - the company's age is calculated arithmetically.
	3. Company size by number of employees	Adapted from the European Innovation Survey (CIS Task Force, 2017)
	4. Company location	Respondents indicate whether the company is located in Urban Centre (Riga) or elsewhere.
	5. Salary group for blue-collar employees	A scale has been developed where the average wage interval in the industry, the minimum wage, and the median wage in Latvia are used for the intervals, and the intervals are adjusted so that the groups are the same size (group intervals 149 Euro).
	6. Salary group for white-collar employees	A scale has been created where the average salary interval for white-collar employees in Latvia is used for the intervals, the median salary in Latvia and the intervals are adjusted so that the groups are the same size (group intervals 249Euro).
2. Employees	7. Education level (master's degree) for white-collar workers.	The scale is formed as a percentage; the size of each subsequent group increases by 10 %.
	8. Company employees receive training to improve their qualifications	Created a statement that is answered using a Likert scale: 1) never; 2) rare; 3) sometimes; 4) often; 5) always.
3. Organizational strategy and culture	9. The company has vacancies (lack of qualified employees)	Likert scale created: 1) positive; 2) rather positive; 3) neutral; 4) rather negative; 5) negative.
	10. The attitude of employees toward the processes of change in the company is	Created a statement that is answered using a Likert scale: 1) do not agree; 2) rather disagree; 3) rather agree; 4) agree.
	11. The company has developed a long-term strategy	
4. Research and development	12. Decisions are made based on a long-term strategy	
	13. The company has an innovative culture	
	14. Has the company carried out in-house research in the last three years?	The dichotomous scale used – a statement created that is answered in the affirmative or the negative: 1) yes; 2) no.
5. Management	15. How was the research carried out in the company?	OECD (2015) classification and explanations of research works were used.
	16. Has the company purchased external research services in the last three years?	The dichotomous scale used – a statement created that is answered in the affirmative or the negative: 1) yes; 2) no.
	17. How important a goal for your company in the last three years has been to acquire new knowledge and technologies	Adapted Likert scale from the European Innovation Survey (CIS Task Force, 2017):
	18. How vital has the goal been for your company to innovate (new products, technologies, and methods) in the last three years?	1) there was no such commitment 2) low importance 3) medium importance 4) high importance 5) very high importance
	19. The company implements measures aimed at increasing employee motivation	Created a statement that is answered using a Likert scale:
6. Exports and competition	20. Employees are informed about the company's strategy or changes in the company	1) never 2) rare 3) sometimes 4) often 5) always
	21. Which countries have the largest share of exports?	Based on the claim that exports to postindustrial countries lead to innovation, the following groups are distinguished:
		1) postindustrial countries 2) BRICA countries 3) countries not mentioned above 4) No export

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(continued)

Category	Question	Scale used
	22. Does the company operate in a highly competitive market (s)?	Created a statement that is answered using a Likert scale: 1) yes 2) rather yes 3) rather not 4) no
7. Knowledge spillover	23. Has the company gained new knowledge from customers in the last three years? 24. Has the company gained new knowledge from suppliers in the last three years? 25. Has the company gained new knowledge from investors in the last three years? 26. Has the company gained new knowledge from other companies in the industry in the last three years? 27. Has the company gained new knowledge from companies in other industries in the last three years? 28. Has the company gained new knowledge from conferences and exhibitions in the last three years? 29. Has the company gained new knowledge from higher education and research institutions in the last three years?	Created a statement that is answered using a Likert scale: 1) never 2) rare 3) sometimes 4) often
8. Process innovations	30. Has the company innovated in the last three years to reduce the use of toxins in the production process? 31. Has the company innovated in the last three years to reduce the use of water and energy in the production process? 32. Has the company innovated in the last three years to increase the use of renewable energy in the production process? 33. Has the company innovated in the last three years to make the production process more efficient? 34. Has the company innovated in the last three years to reduce waste and scrap? 35. Has the company innovated in the last three years to make its products more durable? 36. Has the company introduced new production technologies, such as laser cutting or digital printing, in the last three years? 37. Has the company introduced new production technologies, such as laser cutting or digital printing, in the last three years? 38. Has the company implemented readmission programs in the last three years?	The dichotomous scale used – a statement created that is answered in the affirmative or in the negative: 1) yes 1) no
9. Product innovation	39. In the last three years, the company has developed new products with a view to future product recycling (for example, by creating a product from only one (including threads and fittings), environmentally friendly, recyclable material or by creating products that can be easily broken into smaller units) 40. Has the company developed new products using materials to make the product biodegradable in the last three years? 41. Has the company developed new products using recycled materials in the last three years? 42. In the last three years, the company has developed new products using residue-free constructions? 43. In the last 3 years, has the company started to produce products using materials that extend the product's life cycle?	The dichotomous scale used – a statement created that is answered in the affirmative or in the negative: 1) yes 1) no
10. Organizational innovations	44. Has the company matched supply with demand in the last 3 years? For example, are products made for order only? 45. Has the company, in the last 3 years, set up a system to extend the longevity of products (e.g., product repair)? 46. In the last three years, has the company started to produce products according to individual measures (parameters)?	The dichotomous scale used – a statement created that is answered in the affirmative or in the negative: 1) yes 1) no

Appendix G. Companies' survey – factor questions, answer options, and values

1. CL	Survey question: Please mark the company location:					
Answer	Elsewhere	Riga				
Value	0	1				
2. SBCW	Survey question: Please indicate which salary group is most likely to average the remuneration of blue-collar workers in your company (Blue-collar is the class of employees who perform manual, skilled, or unskilled work):					
Answer	≤ 449	450–599	600–749	750–899	900–1049	≥ 1050
Value	0	0.2	0.4	0.6	0.8	1
3. ISTE	Survey question: How often are company employees trained to improve their qualifications:					
Answer	Never	Rarely	Sometimes	Often	Always	
Value	0	0.25	0.5	0.75	1	
4. EA	Survey question: What is employees' attitude towards the company's change processes?					
Answer	Negative	Rather negative	Neutral	Rather positive	Positive	
Value	0	0.25	0.5	0.75	1	

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(continued)

1. CL	Survey question: Please mark the company location:					
5. ELWCW	Survey question: What proportion of white-collar employees in your company have a master's degree?					
Answer	0 %	1–10 %	11–20 %	21–30 %	31–40 %	41–50 %
Value	0	0.1	0.2	0.3	0.4	0.5
Answer	51–60 %	61–70 %	71–80 %	81–90 %	91–100 %	
Value	0.6	0.7	0.8	0.9	1	
6. LTBS	Survey question: Please assess the situation in your company: The company has developed a long-term strategy					
Answer	Disagree	Rather disagree	Rather agree	Agree		
Value	0	0.33	0.66	1		
7. DBS	Survey question: Please assess the situation in your company: Decisions are made based on a long-term strategy					
Answer	Disagree	Rather disagree	Rather agree	Agree		
Value	0	0.33	0.66	1		
8. ICC	Survey question: Please assess the situation in your company: The company has an innovative culture					
Answer	Disagree	Rather disagree	Rather agree	Agree		
Value	0	0.33	0.66	1		
9. EM	Survey question: How often is the company implementing measures to increase employee motivation?					
Answer	Never	Rarely	Sometimes	Often	Always	
Value	0	0.25	0.5	0.75	1	
10. IE	Survey question: How often are employees informed about the company's strategy or changes in the company?					
Answer	Never	Rarely	Sometimes	Often	Always	
Value	0	0.25	0.5	0.75	1	
11. MGKT	Survey question: How important is the goal for your company – to acquire new knowledge and technologies?					
Answer	No commitment	Low importance	Medium importance	High importance	Very high importance	
Value	0	0.25	0.5	0.75	1	
12. MGTI	Survey question: How important is the goal for your company - To introduce innovations (new products, technologies, and methods)?					
Answer	No commitment	Low importance	Medium importance	High importance	Very high importance	
Value	0	0.25	0.5	0.75	1	
13. IHR	Survey question: Does the company carry out in-house research?					
Answer	No	Yes				
Value	0	1				
14. ERS	Survey question: Does the company buy external research services?					
Answer	No	Yes				
Value	0	1				
15. KI	Survey question: How often does a company gain knowledge from investors?					
Answer	Never	Rarely	Sometimes	Often		
Value	0	0.33	0.66	1		
16. KCI	Survey question: How often does a company gain knowledge from other companies in the industry?					
Answer	Never	Rarely	Sometimes	Often		
Value	0	0.33	0.66	1		
17. KCOI	Survey question: How often does a company gain knowledge from companies in other industries?					
Answer	Never	Rarely	Sometimes	Often		
Value	0	0.33	0.66	1		
18. KCE	Survey question: How often does the company gain knowledge from conferences and exhibitions?					
Answer	Never	Rarely	Sometimes	Often		
Value	0	0.33	0.66	1		
19. KHERI	Survey question: How often does a company gain knowledge from higher education and research institutions?					
Answer	Never	Rarely	Sometimes	Often		
Value	0	0.33	0.66	1		
20. EGC	Survey question: Which countries have the largest share of exports?					
Answer	No export	Other countries	BRICA countries	Postindustrial countries		
Value	0	0.33	0.66	1		
21. CI	Survey question: Does the company operate in a highly competitive market (s)??					
Answer	No	Rather no	Rather yes	Yes		
Value	0	0.33	0.66	1		

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